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POWER

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Progress

I WONDER if we give enough thought and appreciation to those venturesome leaders who, not content with doing an ordinarily good job under existing conditions, have vision enough to see the possibilities that lie beyond the horizon of present attainment and the courage and confidence to go out and realize them.

Take, for example, the prodigious jump in boiler pressures, from the highest that was in actual use when the decision was made, to the 1,200 pounds adopted in 1923 for the Edgar Station of the Edison Electric Illuminating Company of Boston.

Mr. Moultrop, the engineer of that company, saw that a 1,200-pound unit superimposed on the 350-pound system of the station offered increased capacity at a low initial cost and a natural improvement in over-all efficiency.

He believed that it could be done. His belief was not a hunch, but was based upon and verified by a thorough study of every phase of the subject that deliberate foresight could suggest.

It was a long reach into unexplored territory. It was a big venture for the builders of the boiler. There were questions of the probable action of available materials under these extremes of temperature and pressure, possible difficulties with circulation of steam of this density in the boiler and superheater, the fashioning of parts of the weights and thicknesses required. They had even to devise a water gage.

It was something to ask of the turbine builders to furnish a turbine with a pressure upon the exhaust flanges equal to the initial pressure of most turbines, and with all the questions of the flow and effect of steam cf these unknown properties.

It required some nerve, too, on the part of the executives of the purchasing company. Much more than the big investment was at stake.

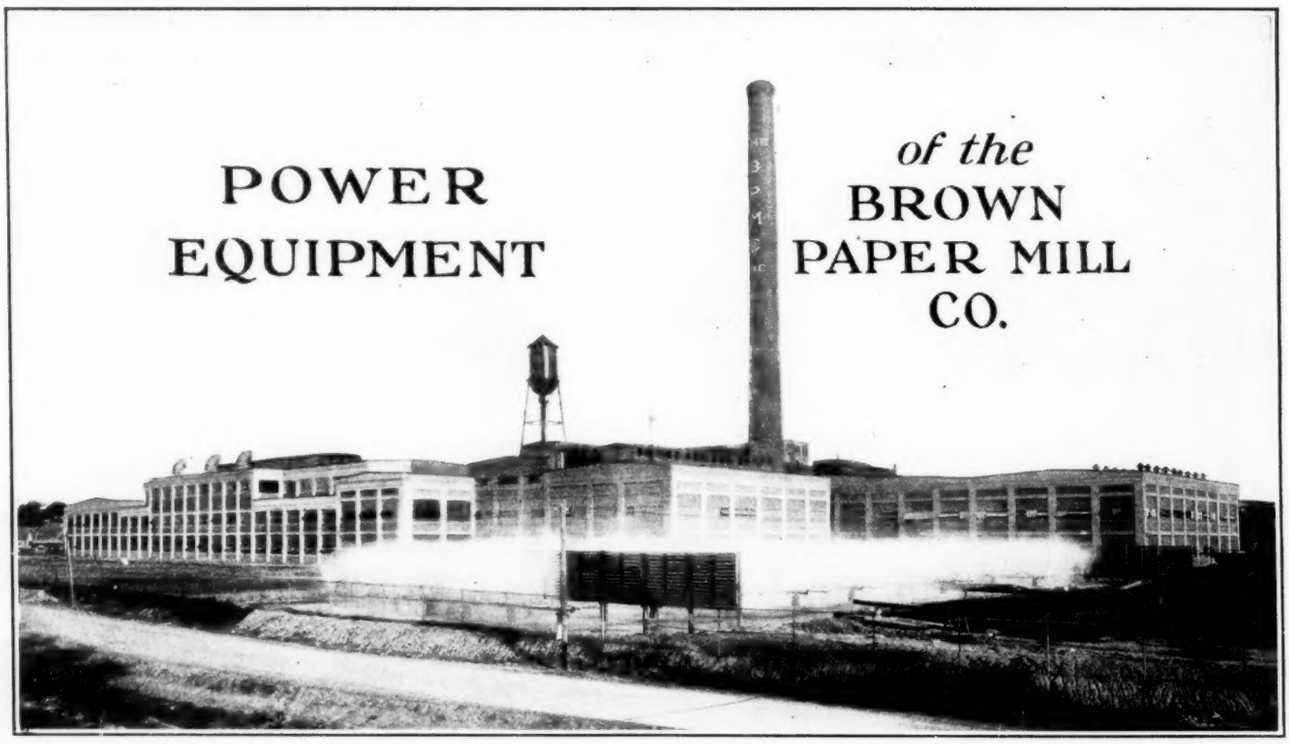
But they were all equal to it. The job was done with Lindbergh thoroughness. The castings were even radiographed.

And it went off with Lindbergh success, fulfilled the expectation of its designer and builders and has demonstrated the practicability of the use of high pressures so convincingly that several other stations are taking advatage of it.

All honor to the men who dare.

F. R. Low

POWER EQUIPMENT *of the* BROWN PAPER MILL CO.



WHILE cheap natural gas eliminates the desirability of many boiler room auxiliaries in the Monroe, La., plant of the Brown Paper Mill Company, the design of the power plant and the application of the process steam and generated power are such that the power cost per ton of paper is as low as is found in more complicated plants.

The present mill consists of the original installation, which puts out 75 tons of paper in 24 hours, and a recent addition that has a like capacity.

When first built, the mill was provided with a boiler plant containing four 8,550-sq.ft. inclined-tube water-tube boilers designed to operate at 200 lb. pressure and provided with superheaters to give 90-deg. superheat. These superheaters are placed behind the first bank of tubes. The furnace temperature and the varying output of the boilers make this type better adapted than a radiant-type superheater. These boilers, in connection with three waste-heat units recently installed, are sufficient for the present plant's needs, even though the mill capacity is double that of the original layout.

While air preheaters, economizers, etc., would permit an increase in thermal efficiency, the overhead charges on their first cost would be greater than the fuel savings. In addition the recoverable heat loss in a plant burning natural gas is not so high as in coal-fired plants. It is possible to operate with but a slight amount of excess air, which reduces the stack loss. On the other hand, a considerable portion of the heat going to the stack cannot be recovered, consisting, as it does, of the latent heat of the water vapor which results from the combustion of the relatively large hydrogen content of the gas. The theoretical CO_2 per cent is 11.2, while the plant regularly shows over 10 per cent with 15 per cent excess air. The gases go to the stack at around 475 deg. F.

All the furnace air enters through the burners; the burner dampers are hand regulated to give about 15 per cent excess air, and the chimney is high enough to give this flow without artificial draft. The burners at present in use are not those shown in Fig. 3. Gas comes from the field at 200 lb. gage, is reduced in the control house to 40 lb., and at the boiler house the pressure is again reduced to give 0.5 oz. at the burners.

In the furnace no special tile is used; the walls are built up of a high-grade Missouri firebrick, and no spawling or melting has occurred. This is due, of course, to the low furnace temperature.

Feed water is heated in an open-type heater and delivered to the boilers by one of three centrifugal pumps. Originally, there were two four-stage pumps direct connected to 100-hp. turbines exhausting into the heater, but these are now used as stand-by units and dependence is placed upon a 4-in. four-stage centrifugal pump with a capacity of 600 gal. per min., direct-connected to a 150-hp. 2,300-volt squirrel-cage motor. All traps from the driers, etc., dump into the heater. The feed makeup is around 40 per cent. No automatic feed control is used, as the experience of the designing engineers indicated that with the boilers installed, no regulator would be able to prevent flooding when the load varied rapidly. When a digester is turned on, the effect is about the same as if a 4-in. line were opened to the atmosphere, and to prevent low water the feed control must be manual. This places no great burden on the boiler man, as he has little else to do.

In the generating room there was originally a 3,750-kva. turbo-generator unit with a direct-connected exciter.

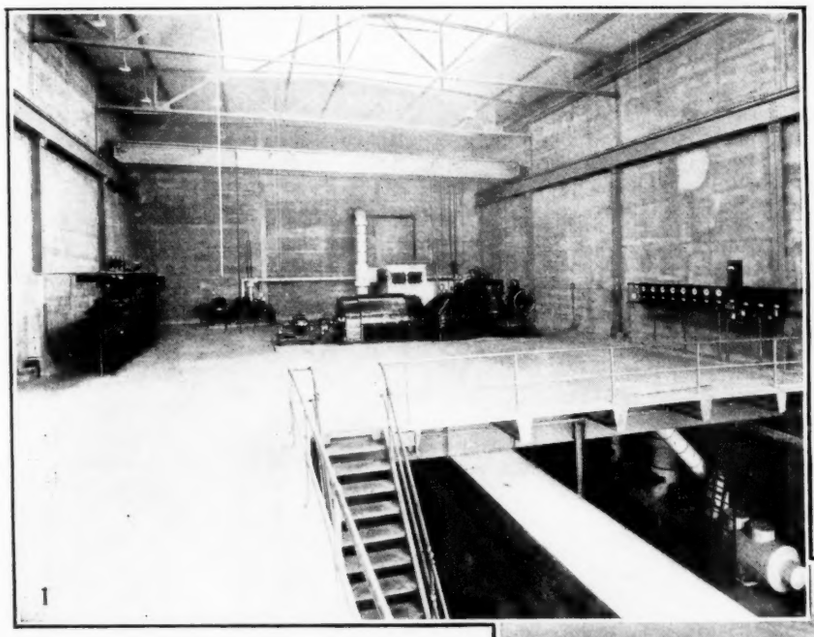


Fig. 1—View of turbine room before installation of 7,500-kva. turbine, showing open heater in the background

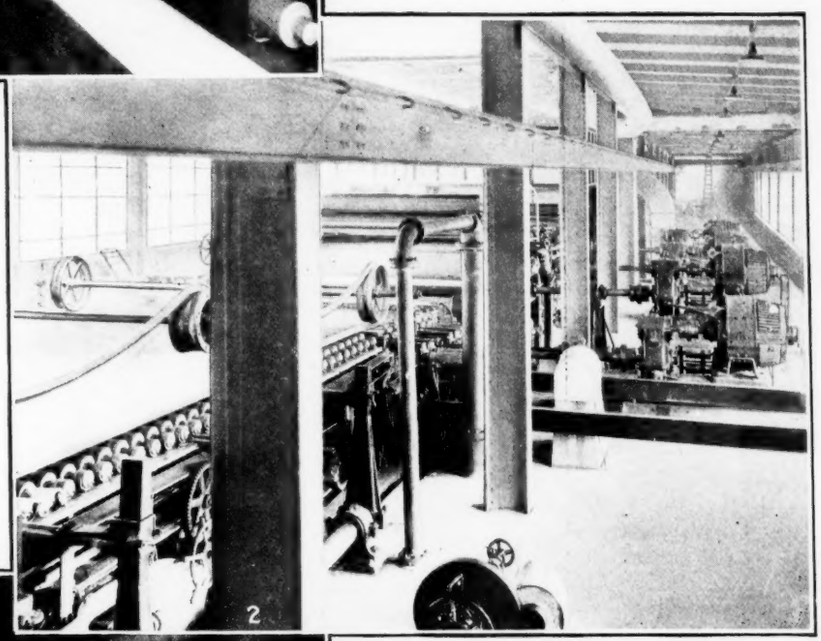


Fig. 2—Part of the paper machine with the variable speed direct-current motors at the right

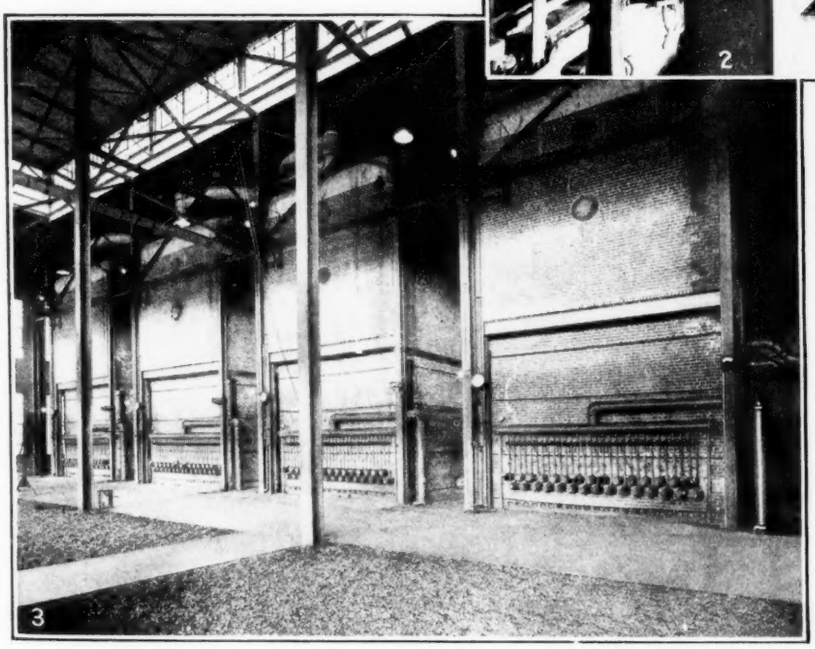


Fig. 3—The boiler room contains four water-tube boilers burning natural gas

From this machine steam was bled at 25 lb. gage, the remainder going to the surface condenser. There has been added a 7,500-kva. unit from which steam is bled at 40 lb. gage from the sixth stage. The rest of the steam expands through the lower stages and passes to the 11,000-sq.ft. surface condenser, which is in the basement below the turbine. An expansion joint and atmospheric relief connection are between the two.

Cooling water for this condenser is handled by a 13,200-gal. per min. centrifugal pump, direct-connected to a squirrel-cage motor. This water is taken from a cold water sump and is forced through the condenser and out of the 397 spray nozzles located above the mill reservoir shown in the foreground of the headpiece. Makeup water and the water that is consumed by the mill comes from an artesian well which flows at a rate of 4,000 gal. per minute.

The water enters the condenser at 82 deg. F. in the summer months and leaves at 88 deg. The high pond temperature is due to the dumping of the hot process water.

The condenser condensate is delivered by a 3-in. three-stage pump, to the feed water heater at around 90 deg. F. The air is removed from the condenser by a two-stage steam-air ejector with intercoolers and aftercoolers.

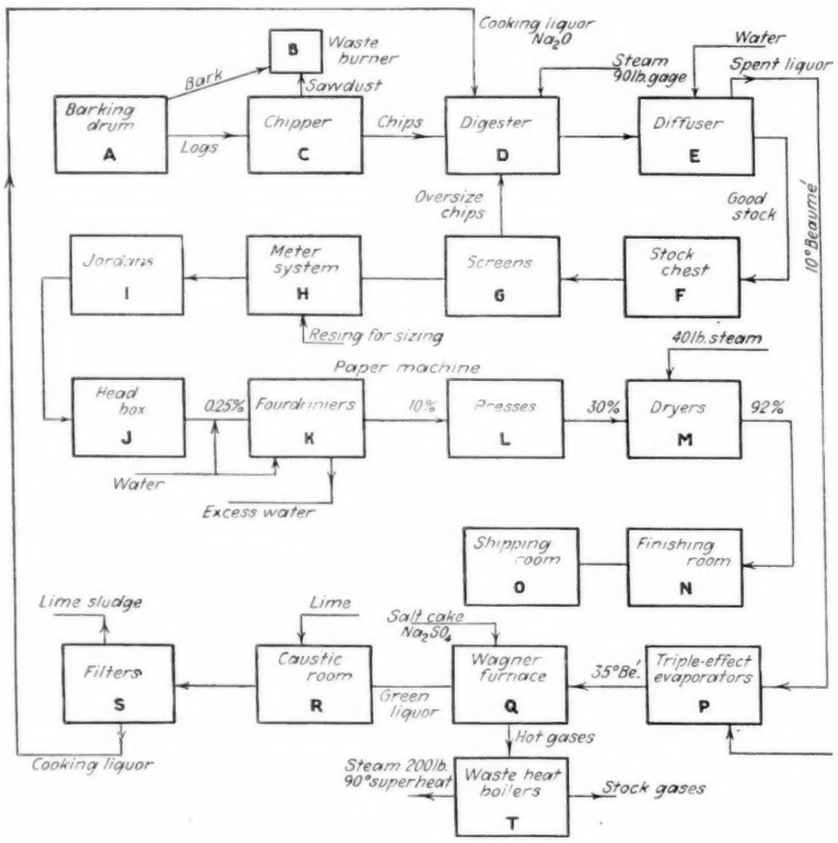


Fig. 4—Diagram of the processes through which paper is made from wood

The generating room has no stand-by exciter set, but service can be obtained from the motor-generator set in the mill used to excite the several synchronous motors of the paper machinery.

The power house is completely equipped with recording flow meters for the feed water and the several steam lines. It is now possible to allocate the steam costs to all the departments using steam. The board carrying these meters is in the turbine room opposite the electrical switchboard.

At present the 7,500-kva. machine is running a 75 per cent load. An average record for 24 hours is 130,000 kw.-hr. with a steam flow to the turbine of 3,000,000 lb. and an extraction of 1,500,000 lb. at 40 lb. This results in the net heat per kilowatt-hour being equivalent to approximately 10 lb. of steam per kilowatt-hour, a value unapproached by central-station practice when line losses are included. Besides the turbines and other machinery mentioned, there were added three vertical waste-heat boilers to recover the heat in the waste from the digesters. These boilers are in the mill building and are handled by the men operating the recovery furnaces, and the arrangement will be discussed along with the processing.

The manufacture of paper is one with which the power engineer is vitally concerned since the processes are so intimately connected with the working of the power house equipment. It is only through the proper balance of generated power and process steam that economy can be obtained. For these reasons a brief description of the main parts of the paper mill will be given.

The arrangement of the principal parts of the new 75-ton mill is shown in Fig. 4. The wood is received in cut lengths of any diameter from 3 to 14 in., and in cutting timber land for pulp wood it is the practice to remove everything standing. The cord wood enters the barking drum *A*, where the bark is removed and passed to the waste burner *B*. The denuded stick goes to the chipper *C*, where sharp knives on the face of a revolving disk cut off chips from the end of the log. Some sawdust is formed and this goes to the burner *B*. The chips are now conveyed to the digesters *D* to be cooked and the fibrous parts separated from resin, oils and soft non-fibrous material. These digesters consist of long cylindrical tanks mounted on trunnions and are revolved at a slow rate. When the chips are charged into the digester, a charge of sodium oxide, Na_2O, is introduced and steam coming from the boilers reduced to 90 lb. gage, performs the cooking process.

The mixture then passes to the diffuser *E*, where water is added. This machine separates the stock by diffusion from the other constituents. The latter, called "spent liquor," go to the triple-effect evaporators *P* at a gravity of 10 deg. Bé. The good stock flows to the stock chest *F* and then to the screens *G*, where the oversize chips are screened out and returned to the digester. The remaining stock goes to *H*, where resin is added for

sizing the paper. The next step carries the stock to the jordan *I*, where knives on a rotating drum break it up and form it into a fibrous substance, after which the matted material goes to the head box of the paper machine *J*. Water is added as the material goes to the Fourdriniers, until the mass has a consistency of 0.25 per cent, in order to make the stock flow readily into a mat. As the mat passes through the Fourdriniers, water is squeezed out until the consistency rises to 10 per cent. The press rolls *L* then raise this to 30 per cent. after

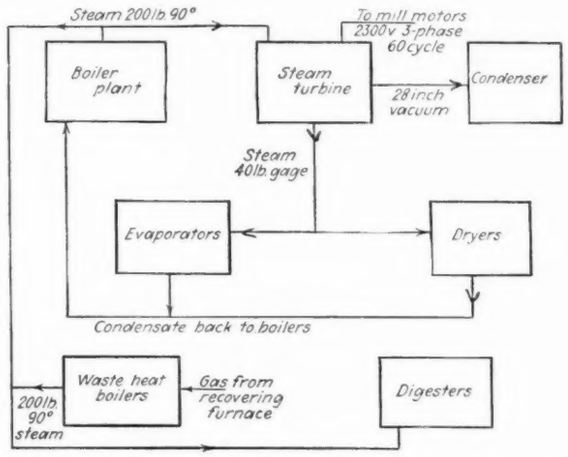


Fig. 5—Hook-up of the steam to the processes

which the paper goes to the driers, where steam coming from the bleeder turbine at 25 to 40 lb. pressure evaporates the water until the paper sheet coming from the driers has but 8 per cent water in it. The next step puts the paper into the finishing room *H* and then into the shipping department *O*.

The spent liquor from the diffusers flows to the evaporator *P*, where the moisture is removed, and the liquor leaves with a gravity of 35 deg. Bé. In the Wagner

PRINCIPAL MILL MOTORS

A.	Barking machine	125-hp. motor, belted
C.	Chipper	125-hp. motor, texrope drive
D.	Digesters (7), each	15-hp., 600-r.p.m. motor, texrope drive
G.	Screens (3), each	100-hp., 1,200-r.p.m. squirrel-cage motor, texrope drive
H.	Meter	Small squirrel-cage motor
I.	Jordans (3 dbl. units) ea.	600-hp., 450-r.p.m. motor, direct connected
J-M	Paper machine	Section drive, with 435-kva. 1,200-r.p.m. motor driving five d.c. generators which drive the several motors
K	Fourdriniers	125-hp. d.c. motor
L.	Presses (3), each	75-hp. d.c. motor
M.	Driers (2), each	125-hp. d.c. motor
N.	Calenders (2), each	125-hp. d.c. motor
	Reel	30-hp. d.c. motor

furnace. *Q* salt cake, Na_2SO_4, is added and the mass burns. The hot gases resulting from the combustion of the woody material in the liquor, together with the turpentine, resin and other oil vapors, go to the three 5,000-sq.ft. waste-heat boilers. Steam at 200 lb. gage and 90 deg. F. superheat is generated and put into the high-pressure steam main. The green liquor from the furnace goes to *R*, where lime is added, and in the filters *S*, the lime sludge is discarded and the recovered cooking liquor is returned to the digesters *D*.

It will be noticed that the heat absorbed by the waste-heat boilers influences the operation of the power plant and reduces the cost of making paper.

All the machinery in the mill is motor driven, much of it through texrope drives, in place of gears or belts. The size, speed and capacities of the principal motors in the new mill are tabulated along with the driven machines.

All these motors are synchronous save where otherwise stated. In addition there are a number of motors handling the air blowers, vacuum pumps, water pumps, etc., but only those directly connected to the main processes are listed.

The speed regulation of the paper machinery gives an output range of from 100 to 1,000 ft. of paper per minute. The control of the motors on the new machine is the General Electric "sectional drive control," while the older machine has the Westinghouse drive.

The speed control on the new machine is an interesting electrical arrangement. A 435-kva. 1,200-r.p.m. synchronous motor receiving current at 2,300 volts and 60 cycles, is mounted on a long sub-base carrying five direct-current generators. These generators are direct connected to the synchronous motor and supply current to the motors on the paper machine. As the synchronous motor operates at constant speed, the speed regulation of the machine motors is obtained through adjusting the field strength of the five direct-current generators.

When the speeds of the several motors have been adjusted so that the driven machine parts have a synchronous speed, the speed of the entire paper machine may be raised or lowered by the shifting of a single bar which cuts in or out segments on the field rheostats of the various generators.

If, however, it is desired to alter the speed of an individual motor, an individual or vernier, control is used. One of these is placed alongside each of the direct current motors and is shown diagrammatically in Fig. 6. This consists of two cone pulleys *B*, one of which is belted to the direct-current motor *A*, and the other cone

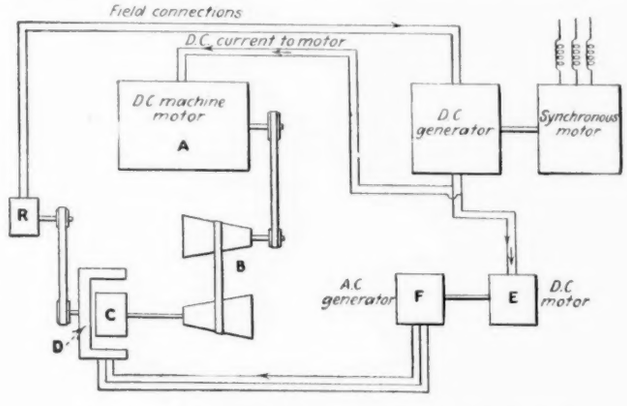


Fig. 6—Diagrammatical layout of the motor speed control

drives the rotor of a small alternating current motor *C*. The coils of the stator *D* of this motor receive current from the small alternating current generator *F* which is driven by the direct-current motor *E*. The latter receives current from the main generator, as does the large driving motor *A*. The stator *D*, which can shift through a small angle, is connected by a belt to the rheostat *R*, this rheostat being connected in the field circuit of the main direct-current generator.

Suppose that it is desired to raise the speed of *A* a slight amount. The belt on the cone is shifted to cause

the rotor *C* to increase in speed. Inasmuch as *D* is receiving current from *F* at a cyclage to cause *C* to revolve at the former speed, the increase in the speed of *C* will cause *D* to shift or rotate through a slight angle. This moves the resistance arm of *R* and the current flowing to the direct-current generator is altered so that the speed of *A* is reduced. As *E* is receiving current at the same voltage, its speed drops, which reduces the cycles of the current going to *D*. The field of the stator *D* then is made to rotate at a rate corresponding to the rate of the rotor *C* which, owing to the reduction in the speed of *A*, has dropped back in speed. The control is of course for minute speed alterations only, and the main control determines the output of the paper machine.

PRINCIPAL POWER PLANT EQUIPMENT OF THE BROWN PAPER MILL, MONROE, LA.

Boilers in power house:	
Number	4
Size, each, sq.ft.	8,550
Pressure, lb. gage	200
Superheat, deg. F.	90
Type	Inclined tube multi-drum water tube
Make	Badenhausen
Superheaters, make	Elsco
Gas burners, make	Duquesne
Steam and water meters	G. E.—Bailey
Feed water heater	Cochrane Corp.
Piping	Grinnell Co.
Feed pumps, type	Centrifugal
Make and drive	One 4-stage Fairbanks-Morse & Co. d.c. to 150-hp. motor; two 4-stage Worthington d.c. to 100-hp. Terry turbines
Turbines, make	Westinghouse Elec. & Mfg. Co.
Type	Bleeding at 25 lb.
Size, kva.	3,750
Turbines, make	General Electric Co.
Type	Bleeding at 40 lb.
Size, kva.	7,500
Condenser, make	Worthington Pump & Mach. Corp.
Sq.ft.	11,000
Air removal	Worthington steam-air jet
Cooling-water pump, type	Centrifugal
Make	Worthington Pump & Mach. Corp.
Capacity, g.p.m.	13,200
Drive	200-hp. 690 r.p.m. sq.-cage motor
Spray nozzles, number	397
Make	Yarnall-Waring Co.
Condensate pump	3 in. 2-stage Worthington d.c. to 15 hp. 1,750 r.p.m. motor
Capacity, g.p.m.	200
Waste heat boilers, number	3
Size, sq.ft.	5,000
Pressure, lb.	200
Superheat, deg. F.	90
Make	Wickes

The Song of Steam*

By G. W. Cutter

Harness me down with your iron bands,
Be sure of your curb and rein;
For I scorn the power of your puny hands,
As the tempest scorns a chain!
How I laughed as I lay concealed from sight
For many a countless hour,
At the childish boast of human might,
And the pride of human power!

When I saw an army upon the land,
A navy upon the seas,
Creeping along, a snail-like band,
Or waiting the wayward breeze;
When I marked the peasant fairly reel
With the toil which he faintly bore,
As he feebly turned the tardy wheel,
Or tugged at the weary oar—

When I measured the panting courser's speed,
The flight of the courier-dove,
As they bore the law a king decreed,
Or the lines of impatient love,
I could not but think how the world would feel
As these were outstripped afar,
When I should be bound to the rushing keel,
Or chained to the flying car!

Ha! ha! ha! they found me at last;
They invited me forth at length;
And I rushed to my throne with a thunder-blast,
And laughed at my iron strength!
Oh! then ye saw a wonderous change
On the earth and ocean wide;
Where now my fiery armies range,
Nor wait for wind or tide.

Hurrah! hurrah! the waters o'er
The mountain's steep decline;
Time—space—have yielded to my power;
The world—the world is mine!
The rivers the sun hath earliest blest,
Or those where his beams decline,
The giant streams of the queenly West,
And the Orient floods divine.

The ocean pales where'er I sweep,
To hear my strength rejoice!
And the monsters of the briny deep
Cower, trembling at my voice.
I carry the wealth to the lord of earth,
The thoughts of his god-like mind;
The wind lags after my flying forth,
The lightning is left behind.

In the darksome depths of the fathomless mine,
My tireless arm doth play;
Where the rocks never saw the sun's decline,
Or the dawn of the glorious day.
I bring earth's glittering jewels up
From the hidden cave below,
And I make the fountain's granite cup
With a crystal gush o'erflow.

I blow the bellows, I forge the steel,
In all the shops of trade;
I hammer the ore and turn the wheel,
Where my arms of strength are made.
I manage the furnace, the mill, the mint;
I carry, I spin, I weave;
And all my doings I put into print
On every Saturday eve.

I've no muscle to weary, no breast to decay,
No bones to be laid on the "shelf";
And soon I intend you may "go and play,"
While I manage this world myself.
But harness me down with your iron bands,
Be sure of your curb and rein;
For I scorn the strength of your puny hands,
As the tempest scorns a chain!

*This poem, the author of which was a captain in the United States Army during the invasion of Mexico, was sent to *Power*, by John Homewood, of Ontario, California, who found it while looking through old books.—Editor.

Horizontal Return-Tubular Boilers

By D. D. EAMES

Engineer with Lockwood, Greene & Company, Inc., Boston, Mass.

Tubular boilers occupy a wide field of use at the present time, and will doubtless continue to do so. In the method of installing this type of boiler, there is generally room for great improvement over methods usually followed. This article invites consideration for some of these improvements as well as of some of the characteristics of the horizontal return-tubular boilers themselves

INSURANCE statistics indicate that for industrial sections of the country horizontal return-tubular boilers exceed water-tube boilers both in number of installations and in total capacity. The preponderance in favor of tubular boilers would undoubtedly be even more marked for the non-industrial sections, but no figures in proof of this are at hand. This situation is largely lost sight of by people having to do with power plants because of the extent of literature dealing with water-tube boilers and their related problems. It is not difficult to understand the reason for this. The installations of large units of water-tube boilers to be operated at high capacities justify the expenditure of large sums of money for improvement of economy. The research and experimentation devoted to this aim has eclipsed the problems of the tubular boilers, which are smaller individually but larger in the aggregate, considering the amount of fuel used, than those of their more pretentious water-tube brethren. The field of usefulness of tubular boilers is limited except in some special cases, to medium and small-sized industrial plants, or in other words to plants requiring steam in relatively small quantities and at moderate pressures. Any tendency toward purchase of power by industrial plants will not reduce the field of the tubular boiler, but may, on the contrary, increase it through the use of smaller units at moderate pressure supplying steam for heating and process work.

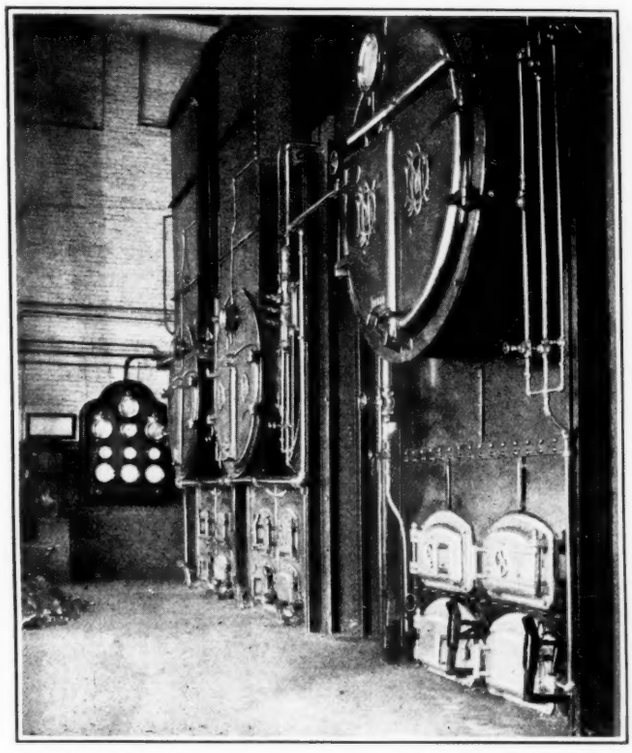


Fig. 1—Note the low settings of the 20-year boilers compared with the recently installed boiler

The efficiency of a horizontal return tubular boiler may be considered equal to that of a water-tube boiler of equal size and equivalent installation and operation. It is never economically sound to install an h.r.t. boiler with the refinements and fuel saving equipment that are found on large water-tube boilers. Consequently, the efficiency of an h.r.t. unit will not be so good as the published efficiencies of modern water-tube units. But the efficiency expressed in pounds of steam generated per dollar invested will probably be equally good. An h.r.t. boiler is not well adapted to operation at high ratings; 150 per cent may be considered as a fair limit for efficient operation. Many boilers are operating at higher ratings than this, but at a sacrifice of efficiency. Uptake temperatures as high as 700 deg. have been observed on horizontal tubular boilers running between 175 and 200 per cent and this high temperature indicates that the limit of economical operation has been exceeded. Horizontal tubular boilers may be fired with any of the fuels and any of the methods used for water-tube boilers. Some of these methods will be found advisable or economically justified, however, only in rare and exceptional cases.

Local conditions such as the availability of good firemen or the policy of the management will frequently determine the method of firing. Needless to say, hand firing on a flat grate is the least expensive arrangement

in first cost. A hand stoker is superior to a flat grate provided a suitable grade of coal and the correct method of firing are used. A coking coal is best for this type of stoker. It should be coked on the front end of the stoker and then worked back. If the coal is spread over the entire grate, as would be proper for a flat grate, a hand stoker is no better and probably not so good as the flat grate. One disadvantage in some instances of the hand stoker is the deeper ashpit required.

A forced-draft stoker may be justifiable for an h.r.t. boiler by any one of several reasons. Suitable hand labor may not be available; the few points better efficiency that should be possible with this equipment may justify its cost; ability to meet peak loads may be a vital factor; or smokeless combustion may be necessary to meet a city ordinance. A correctly designed stoker installation, correctly operated, will enable any of these conditions to be met. Pulverized coal has been applied in a number of instances to h.r.t. boilers and with at least a measure of success. The shape of furnace that can be built under these boilers is not, in the writer's opinion at least, what is most suitable for this fuel. The present state of the art seems to require furnaces not only of sufficiently large volume, but also having a width of greater dimension than is usual for h.r.t. boilers. If this furnace requirement is not observed, extra maintenance of refractories may be expected.

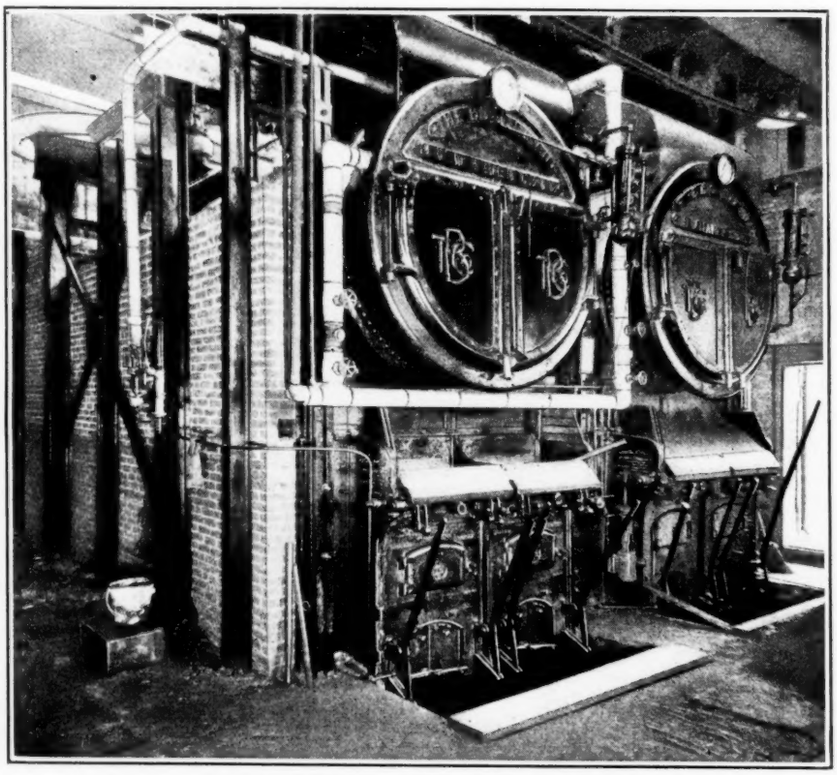


Fig. 2—In these two boilers the supporting steelwork is arranged in accordance with good design

Oil is an ideal fuel, but is usually more expensive than coal. In some plants, on account of situation or product, the advantages outweigh the cost and justify its use.

The first cost of h.r.t. boilers does not vary among different manufacturers over nearly as great a range as that of water-tube boilers. The reason is doubtless that the designs of water-tube boilers differ widely, whereas the h.r.t. boilers are so nearly standardized that the only opportunities for variations in cost are such items as cost of material, freight, shop costs, and above all, quality of workmanship. As a rough comparison, h.r.t. boilers will cost about 55 per cent as much per square foot as straight-tube water-tube boilers of the best design and quality, and about 65 per cent as much as the bent-tube type. The brick settings will also cost slightly less than the brickwork for water-tube boilers. Such cost comparisons as these must necessarily be recognized as very general, the exact costs depending on the design of any particular case.

A table of the more common sizes of h.r.t. boilers would be something as follows, considering for each size a manhole in the front head below the tubes:

Diameter, In.	Tubes			Heating Surface	H.P.
	Number	Size, In.	Length		
60	72	3	16	985	99
66	98	3	16	1,304	130
72	96	3½	18	1,674	169
78	114	3½	20	2,186	217
84	142	3½	20	2,690	267

A great number of variations of these sizes can be made by varying the number, size and length of the tubes. These boilers are, of course, built in diameters both smaller and larger than listed above. The smaller sizes are not commercially very important. The larger sizes are not numerous, the reason being doubtless, that they can be built only for moderate steam pressures. If high pressures are attempted, the plate thickness becomes excessive. The following table gives the allowable pressures for different thicknesses of plate for different sizes of boilers. Girth seams for plates over $\frac{9}{16}$ in. must be planed to $\frac{9}{16}$ in.

ALLOWABLE PRESSURE, LB. PER SQ.IN.

Plate, In.	Diameter, In.			
	72	78	84	90
1/2	144	133	123	115
17/32	153	141	131	122
9/16	162	148	139	128
19/32	169	156	145	136
5/8	178	165	153	143
21/32	187	173	161	150
11/16	195	180	167	156
23/32	204	188	175	163
3/4	212	196	182	170

Method of Setting

It used to be common practice to set h.r.t. boilers in continuous batteries of four or six or even more. If the boilers were suspended from overhead beams, it was necessary to arrange ventilating ducts through the battery walls around the inside supporting columns. A better way is to set the boilers in batteries of two with

alleys between. This uses a little more building space, but makes a much more advantageous arrangement. All supporting columns can be kept out in the open, battery walls with their greater maintenance requirements are reduced in number, stoker access doors can be provided, and the brick setting walls can be more adequately supported by buckstays.

The same reasons that have brought about the large furnace heights for water-tube boilers apply to the furnace heights for h.r.t. boilers in a proportionate way. Boilers that used to be set two and one-half or three feet above the grates are now set at twice these distances. The idea is to provide sufficient combustion space so that the volatile elements of the fuel may have time to burn completely before coming in contact with the comparatively cool boiler shell. Excessive heights should be avoided, not only on account of the unnecessary expense involved, but because of the reduction of radiant heat received by the boiler. The amount of radiant heat available to a heat absorbing surface from an incandescent fuel bed varies inversely as the square of the intervening distance; for example, if the distance is doubled, the radiant heat absorption is reduced to one-quarter. In addition to the absorption by direct radiation there is an additional absorption of heat reflected from the furnace walls.

Overhead Suspension

The A.S.M.E. and the Massachusetts and Ohio Boiler Codes require that boilers over 78 in. in diameter be supported by the outside suspended type of setting. This requirement by law is on account of the increased safety of the overhead support as compared with the method of carrying the weight directly on the brick setting walls. There are other incidental advantages to the overhead method of supporting, principally in connection with the maintenance of the brickwork, and it seems probable that the extra cost of the outside suspension is usually justified and advisable for boilers down to and including 72 inches.

In designing an overhead supporting structure, certain features may be kept in mind. The columns should be entirely clear of the brick side walls. There is nothing gained by recessing the columns part way into the wall; on the contrary, the wall is weakened and opportunity given for a crack to start. The columns may be either cast iron or steel. If the latter, an H-section should be used, set with the flanges parallel to the side walls of the setting. The inside flange should be in line with the face of the setting wall, to which it will then serve as a support. Diagonal bracing should be provided between the front and rear columns on each side. If this is not done, the structure will lack stability. Lateral stability may be partly secured by providing a good connection between the top ends of the columns and the beams, but the principal stability in this direction is provided by the setting walls. The diagonal bracing should be arranged to be clear of the brickwork. The overhead beams should be double I-beams. The best type of connection to the boiler is the U-bolt.

Boiler Fronts

Other steelwork required for a good h.r.t. boiler installation includes the fronts and the buckstays and tie rods. The item of fronts is one which, under stress of competition, has been greatly skimped by manufacturers, with the result that a great many installations are found with front walls pushed out of plumb either at the top or bottom. For high-set boilers steel plate is the only suitable material for the fronts. The plate should not be less than $\frac{5}{16}$ in. for the small sizes and $\frac{3}{8}$ in. for the large, and should be stiffened horizontally and vertically by angles or tee-bars. The front should cover the entire front width of brickwork, and if the front setting wall is carried up to the top of the boiler, the steel part should also cover the upper corners. The front is secured firmly in position and stiffened vertically by buckstays located in line with each of the longitudinal walls of the setting. These buckstays are connected by tie rods to similar buckstays on the rear wall of the setting. The tie rods rest on the top of the side walls, or about 1 in. above the center line of the boiler and well away from the heat. Short rods extending into the brick walls for holding the fronts are of no value, as they soon burn off.

The fronts of a double battery of boilers should be separated by a space of an inch or more on a vertical line midway between boilers, to allow for expansion. The middle buckstay will cover the joint, slotted holes being used for the connection of buckstays to plate on one side. Additional support for the front corner of the brickwork and a finish strip for the edge of the steel front may be provided by a vertical corner angle.

The steel front should be insulated from the heat of the wall by a layer of asbestos between the steel and the brick, the insulation extending from the top of the arches on the doors up to the center line of the boiler.

Buckstays

The matter of buckstays for h.r.t. boiler settings is one upon which there has been much difference of opinion. Some advocate omitting the buckstays entirely, and can show numerous examples of good boiler settings without them. Much of the feeling against buckstays can undoubtedly be traced to faults in the design of the buckstays themselves. A buckstay, to be any good, must be so rigid that it will support the wall over its entire height. If the buckstay is not rigid, it will deflect away from the wall at the middle and bear hard on the top edge. This will almost always start a crack in the wall due to local pressure, and it would probably have been better not to have had any buckstays. For the height of wall ordinarily found with h.r.t. boilers, buckstays made up of two 6 in. 8.2 lb. channels back to back will be found satisfactory. Buckstays made up of a steel plate pressed into a shallow U-section are of no value whatever. Additional bracing and supports for the side walls may be obtained by placing the boiler supporting columns so that they will bear against the outside face of the brickwork, as previously described.

Brickwork

The brickwork for h.r.t. boilers deserves careful study to secure good design. Such settings are not as intricate as water-tube settings, but there are some conditions which must be observed for satisfactory results. Two main essentials are to be sought, namely: a setting that will be free of any large cracks or air leaks, and one that can be repaired or relined in the furnace, at the same time retaining the bond between the firebrick and red brick. The first is a matter of design, the second of proper materials and workmanship. Brickwork, like other materials, expands with increase of temperature.

If the expansion is to be prevented from damaging the walls, two things must be taken care of: first, expansion joints or spaces must be provided; and second, the walls must be so bound together by steelwork that the expansion movement will be forced to occur in the places intended.

The most effectual locations for expansion joints are in the outside rear corners, at the rear end of the battery wall, and at the ends of the bridge walls. Vertical zigzag expansion slots 4½ in. deep should also be provided in the furnace lining. These slots should be spaced not over four feet apart and should be open about $\frac{3}{16}$ in. The expansion movement to be expected, theoretically, in furnaces built of Pennsylvania clay brick is about one-half of 1 per cent of the length of wall, but experience has shown that if joints are left for this full amount they are unnecessarily wide. All expansion joints must be packed, both to prevent the heat from attacking the wall and to prevent air leakage from outside. Joints extending through the wall should be located so that they will be backed up by a buckstay. Between these buckstays and the wall there should be a 10 in. wide strip of ¼-in. asbestos millboard, and a steel plate, the millboard being against the wall.

The inside zigzag joints may be packed with ⅛ in. indented roll fire felt, which will leave an actual space of about $\frac{3}{16}$ in. between the brick.

Construction of Walls

The walls of the setting may be built of the following thicknesses:

Side walls	21 in. firebrick and red brick
Battery walls	27 in. solid firebrick to rear face of bridge-wall
Rear walls	21 in. firebrick and red brick
Front walls	13½ solid firebrick
Bridge walls	27 in. solid firebrick

The side walls of the furnace are usually lined with 9 in. of firebrick as far back as the rear of the bridge-wall. Behind this point the lining may be reduced to 4½ in. for the side and rear walls. The battery wall should be solid firebrick within the furnace limits. If red brick are used in the center of the battery wall, the wall is weakened and the saving in cost over solid firebrick is very small. The bridge-wall should be solid firebrick or faced with 13½ in. firebrick on furnace side and top. The ends of the bridge wall extend about 3 in. into a 4-in. recess at the side of the walls, 1 in. clearance being left for expansion. The furnace walls should be vertical. The grate or stoker should be 1 in. or 2 in. wider than the nominal diameter of the boiler, thus allowing for vertical walls with a projecting course at the boiler center line to retain the asbestos rope packing.

Solid Versus Hollow Walls

The boiler setting walls should be solid. The old practice of leaving a dead air space in the walls is wrong theoretically and practically. The theory was that the air space acted as an insulator and reduced radiation losses. This has been proved wrong by Bureau of Mines tests.[1] A rough way of stating the result of the tests is that as an insulator a 2-in. air space is equal to 2 in. of solid wall at about 500 deg. temperature. At lower temperatures the air space is better and at higher temperatures the solid wall is better. Boiler setting walls at the point where the air space would come are hotter than 500 deg., consequently the air space makes a poorer insulation than an equal amount of solid wall.

The air space is wrong practically because it makes the weakest form of wall construction, inviting the formation of cracks and air leaks into the furnace. In some settings with air space walls vent pipes have been built through the outside walls. These vents permit some air circulation through the spaces, which is exactly what is not wanted and also would give a ready supply of air to any cracks through the inner wall directly into the furnace.

The writer has found that in some localities there is a strong sentiment in favor of air space walls, one of these localities for instance being the Connecticut Valley of Massachusetts and Connecticut.

Method of Laying Firebrick

The main requirements for laying up a boiler setting wall correctly are that the firebrick and the red brick courses be level and that the wall be laid with tight bed and cross-joints. In order to lay up in level courses, the red brick must not be more than 2¼ in. thick, thus allowing a ¼-in. joint between the red brick. The firebrick should be laid with the thinnest possible joints, the brick being in actual contact, and only the irregularities of the surfaces being filled with the fireclay batter. After a wall has been built, a measurement over nine courses of red brick of 23 in. or at the most 23½ in., will show that it has been laid up with level courses. If nine courses measure more than 23½ in., it is proof that this method of construction has not been followed.

The walls should be carried up one course at a time. The common practice of building the inside and outside faces several courses high and then filling in between with promiscuous material is entirely wrong. The correct bond between red brick and firebrick cannot be secured in this way. The firebrick should be tied to the red brick by a header at every fourth or at the most every fifth course. Directly under the firebrick header should be a red brick header, and so on with other red brick headers through to the outside face of the wall. By this construction the headers form a series of steps through the wall which will support the inside face when sections are cut out for repairs. This construction also takes the place of relieving arches built to support the firebrick side of the wall. Repairs to a wall built in this way can be effectually made because the original bond can be maintained. If the wall was originally laid up with uneven courses, the new work cannot be bonded and is likely to work loose after short service.

A boiler wall carefully built as described and properly provided with expansion joints and buckstays, will sometimes crack. The cracks will, however, usually be small and easily pointed up. On the other hand, a poorly constructed wall will sometimes not crack simply because it is so loosely built that expansion strains are readily absorbed in the wall itself. The presence or absence of cracks, therefore, does not necessarily indicate that the workmanship has been poor or good.

There has been a tendency of late to use all firebrick wall construction instead of red brick and firebrick. This makes a more expensive wall and, in the writer's opinion, does not bring corresponding advantages. When all firebrick construction is felt to be justified, however, full-sized brick laid up with thin joints in courses level with the inside courses should be used. This is in contrast

[1] Bulletin No. 8, Kreisinger & Ray, 1912.

with the practice sometimes followed of using a thinner firebrick laid up in lime mortar. This has nothing to recommend it over good red brick construction.

Blowoff Pipe

The blowoff pipe is usually placed at the rear end of the boiler, which is set one inch, or sometimes two inches, lower than the front. The blowoff pipe should be carried straight down through the floor of the combustion chamber, then out horizontally through the rear wall of the setting about six inches above the floor. The vertical section of blowoff pipe must be protected by a baffle of firebrick or special U-shaped tile. A steel sleeve should be provided through the rear wall for the blowoff pipe, the sleeve being large enough to allow plenty of room for expansion.

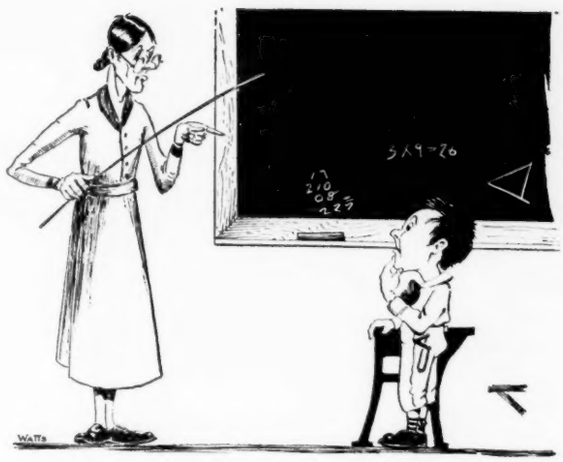
Recently, a number of installations have been made with the blowoff pipe at the front. There are a number of advantages to this location, chiefly that the pipe is kept away from the heat of the combustion chamber. There is a doubt, however, as to whether the front end of the boiler is as good a position for the blowoff as the rear. The theory is that the heat directly over the fire sets up a circulation which tends to deposit the dirt at the back end. If this be true, even where the boiler is pitched toward the front, the front end location of the blowoff pipe will not be successful. Reports on the experience of installations already made will be helpful in this connection.

With regard to circulation in an h.r.t. boiler, it has always been recognized that its direction and rapidity are uncertain. There would undoubtedly be a difference in the circulation in two boilers, one of which was fired with coal on a grate at the front, and another fired with oil or pulverized coal where the hottest part of the furnace was farther toward the rear.

The illustrations accompanying this article show two plants having boilers installed as described. Fig. 1 shows three boilers, two of which are 72-in. boilers installed over 20 years ago, and one 84-in. boiler installed recently. The older units were originally installed with the ordinary type of fronts, which were in poor condition, and when the larger boiler was ready for operation, the settings of the older boilers were thoroughly repaired and fitted with new fronts and buckstays.

Fig. 2 shows a plant with two 78-in. boilers having hopper-feed hand stokers. This picture shows the supporting steelwork and buckstays arranged according to the methods described.

The American Petroleum Institute estimates that the daily average gross crude oil production in the United States for the week ended Jan. 21 was 2,380,900 barrels as compared with 2,373,100 barrels for the preceding week, an increase of 7,800 barrels. The daily average production east of California was 1,764,300 barrels, as compared with 1,757,500 barrels, an increase of 6,800 barrels. Imports of petroleum (crude and refined oils) at the principal United States ports for the same week totaled 1,283,000 barrels, a daily average of 183,286 barrels, compared with 1,386,000 barrels, a daily average of 198,000 barrels for the week ended January 14, and a daily average of 193,071 barrels for the four weeks ended Jan. 21.



What Do You Know?

By L. H. Morrison

The answers are on page 304

MOST of us suffer from a non-understanding of basic principles. We build too many of our conclusions on what we have observed or think we have observed. For this reason all occasionally slip. In the questions below are several that go into the heart of things, and if you are not careful your answers will fail a high score. See how you and the editor agree.

Ques. 1—The approximate flow of steam through an orifice can be found by Napier's formula $M = \frac{AP}{70}$, where A is area of nozzle in square inches, P the steam pressure in pounds per square inch absolute and M the pounds of steam per second. If a nozzle is at the end of a 1-in. pipe 100 ft. long and the boiler pressure is 100 lb. gage, could the flow through the orifice be found by inserting this pressure in the formula given?

Ques. 2—An elevator is accelerated at a constant rate of 6 ft. per sec. per sec. If the car and load weigh 6,000 lb. and the counterweight 4,000, what is the force acting on the lifting cable at the crosshead located on the top of the cage, ignoring the frictional resistance?

Ques. 3—What is the hydraulic efficiency of a pump?

Ques. 4—If a flyball governor revolves at 100 r.p.m., will the speed of the engine be changed, the load remaining constant, if the weight of the balls is doubled?

Ques. 5—Suppose a non-condensing slide-valve steam engine is driving an alternator in parallel with another machine. If the engineer shuts off the steam from the slide-valve engine without opening the generator switch, so that the alternator is motorized by the second machine, will the engine pump air back into the steam chest? Suppose the direction of rotation of the motoring alternator is reversed, would the engine pump air back?

Ques. 6—Is there any fuel or crude oil in oil shale?

Ques. 7—If a tank 10 ft. in diameter by 10 ft. high is filled with water at 30 deg. F. up to the point of overflowing, will the water overflow if heated to 50 deg. F.?

Ques. 8—How would you prevent a steam heating boiler from losing its water level through the water backing up the return, and still use no check?

Ques. 9—What is the size of No. 4 Buckwheat coal?

Field Balancing Rotors at Operating Speed

By G. B. KARELITZ

Research Department, Westinghouse Electric & Manufacturing Company

IN THE first article on this subject, published in the February 7 issue the forces acting to cause vibration were analyzed. In this concluding article is described a mechanical method for determining the location and size of correction weights necessary for eliminating rotor vibrations.

WHEN balancing a running rotor, no attempt should be made to work on both ends at once. It will usually be found best to start balancing at the coupling end first. The magnitude and location of the correction weight which, when inserted into the balancing ring will eliminate the vibration of the bearing pedestal at this end of the rotor, can be found on the basis of the vector diagram shown in Fig. 2 of the previous issue. For this purpose it is only necessary to make three trial runs, for which the weights of the trial balancing plugs, the numbers of the holes into which they are screwed and the amplitudes of the pedestal vibration are recorded.

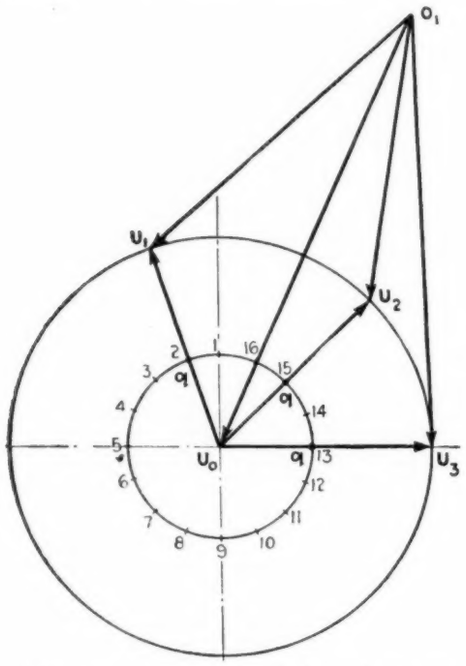


Fig. 1—Diagram of unbalanced vectors

Let it be assumed that the initial amplitude so found is a_0. Let a correction weight of q oz. be put in at random in the balancing ring I and the machine started again. The new amplitude of vibration at full speed will then be a_1. The correction weight is then shifted consecutively into two other positions on the balancing ring and the amplitudes during these two trial runs found to be a_2 and a_3. The trial weights may be of different weights for the three runs, and this case will be considered later; for the present the weights will be assumed equal to q oz. for each run.

Using the diagram of Fig. 2, assume that the balancing ring of the rotor has 16 holes $22\frac{1}{2}$ deg. apart; the observations made are:

Trial run	1	2	3
Weight, oz.	q	q	q
Location, hole No.	2	15	13
Amplitude of vibration	a_1	a_2	a_3

The corresponding part of the diagram Fig. 2 (issue of Feb. 7) is redrawn in Fig. 1. The unbalance vectors O_1U_1, O_1U_2, O_1U_3 and the initial vector O_1U_0 must be proportional to the observed values a_1, a_2, a_3 and a_0.

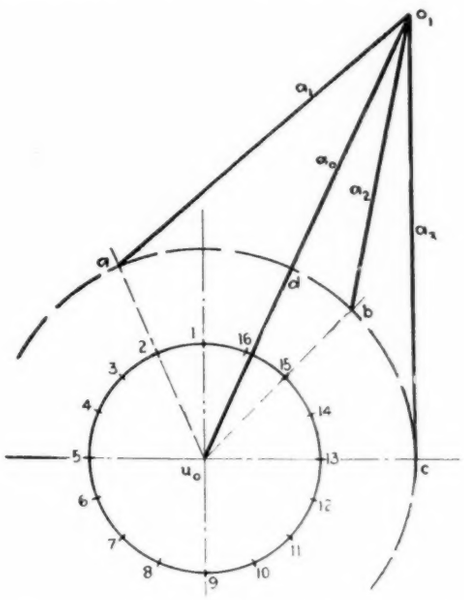


Fig. 2—Diagram to be constructed from test data when using trial plugs of equal weight

respectively. Thus, the lengths O_1U_1, O_1U_2, O_1U_3 represent to a certain scale the values a_1, a_2, a_3, the length O_1U_o giving to the same scale, the original amplitude a_o. Therefore, knowing the values of a_1, a_2, a_3 and the directions U_oU_1, U_oU_2, U_oU_3 through holes Nos. 2, 15 and 13, a figure similar to the unbalance vector diagram $O_1U_oU_1U_2U_3$ can be constructed.

The geometrical problem is to construct a figure Fig. 2, where $o_1a = a_1$; $o_1b = a_2$; $o_1c = a_3$, the points a, b, c

TABLE I—LOG OF BALANCING WITH EQUAL WEIGHTS

Run No.	Vibration	Trial Weight, Oz.	Hole No.	Amplitudes, In. Coupling End	Amplitudes, In. Thrust End	Remarks
1	Medium	None	..	0.0029	0.0015	High spot at coupling end holes 20-21.
2	Same	23	2	0.0021	0.0020	High spot shifted toward weight.
3	Same	23	5	0.0030	0.0021	No markings taken.
4	Better	23	27	0.0019	0.0012	Shaft marking stretched out.
	Applied unbalance finder	23	28			
5	Smooth	23	27	0	0.001	
		10	26			

must remain on the lines u_o2, u_o15, u_o13 respectively and lie on a circle with the center u_o. This done, the direction of o_1u_o will show the direction of the original unbalance and the location of the correction weight P on the radius

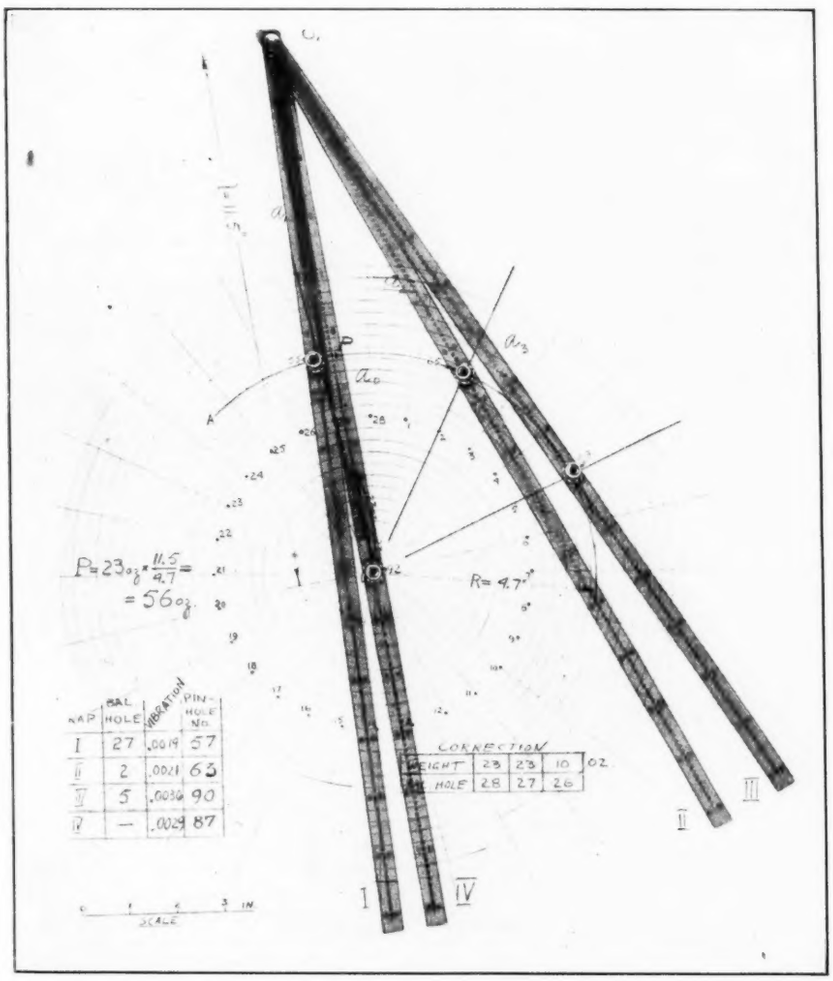


Fig. 3—Application of unbalance finder when equal trial weights are used

u_od. The length o_1u_o should give the value of a_o, thus being a check of the construction.

The amount of unbalance or the necessary correction P_1 is computed from the length of o_1u_o; this length represents P_1 in the same scale as the radius u_oc represents the trial weight q; $P = q\,\frac{o_1u_o}{u_oc}$ oz.

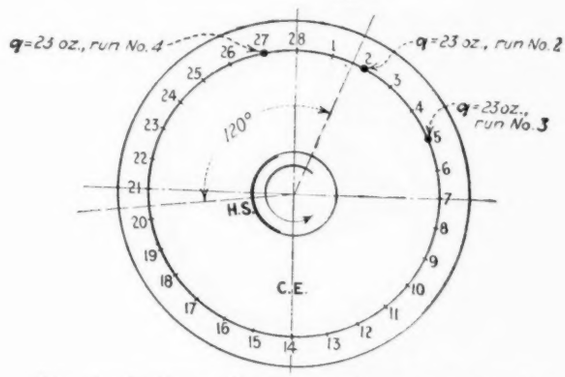


Fig. 4—Balance ring of turbine rotor, showing location of trial weights

A geometrical construction of the diagram in Fig. 2 by trial and error would be a tedious process; therefore a mechanical device was made to assist in a quick determination of the amount and position of the unbalance. The "unbalance finder" consists of four thin identical transparent straps pivoted together at one end. Each of the straps is graduated up to 150 units, starting from the pivot as a zero point. Pinholes mark the graduation, as seen in Fig. 3. Operation of the instrument will be shown best by describing its application in two cases of actual balancing.

A large turbine rotor, running at 1,800 r.p.m., was balanced. The balancing ring of the coupling end (Fig. 4), where the operation was started, had 28 equidistant holes. The vibration of the spindle was "medium." The spindle shaft was "scribed" as usual; it was known that for this type of machine the unbalance is somewhere 60 deg. ahead (in the direction of rotation) of the "high spot" of the marking; that is, the correction weights should be placed somewhere near a point 120 deg. behind this "high spot." The log of the balancing report is shown in Table I.

The computation is shown in Fig. 3. The pinholes 57, 03, 90 were taken on straps *I*, *II*, *III* to represent proportionally the amplitudes of vibration with the trial weight $q = 23$ oz. in the holes No. 27, 2, 5 respectively. The pins a, b and c were slid back and forth along the lines 0-27, 0-2, 0-5 until all pins came approximately on the same circle, AB, with the strap *IV* registering at the center U_o the number 92, which nearly corresponded to the initial amplitude 0.0029 in. The inaccuracy is evenly divided among all four vectors. The location of the correction weight P was indicated between holes

27 and 28. From the length of $O_1U_o = 11.5$ in. and of the radius of AB equal to $R = 4.7$ in. with $q = 23$ oz., the correction weight was found to be $P = 23 \times \frac{11.5}{4.7} = 56$ oz.

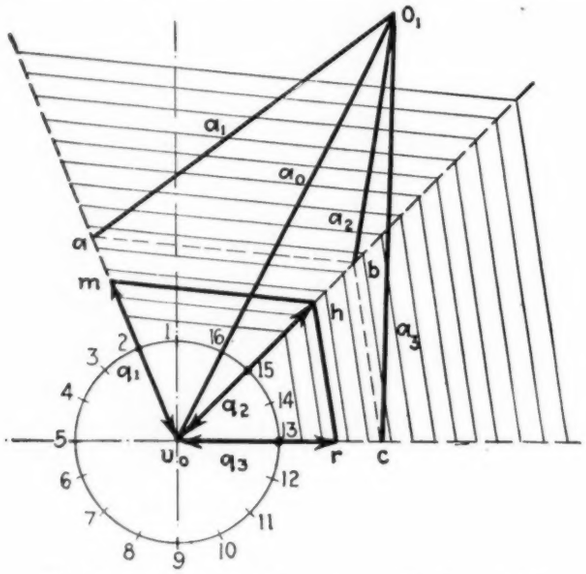


Fig. 5—Diagram to be constructed when using unequal trial weights

This weight was made up of two plugs 23 oz. each in holes 28 and 27 and a 10-oz. plug in hole 28. When combined vectorially as shown in Fig. 3, these three plugs are equivalent to one weight of 56 oz. at P.

The case taken for illustration shows an exceptionally accurate performance of the method. In general, however, the vibration of the pedestal is not brought to zero when the computed correction is placed in the balancing ring, but to a small value commercially satisfactory. It is sometimes impossible to bring a, b and c on the same circle and have at the same time the correct reading on the strap II'. The discrepancy is due partly to the approximation of the assumption of proportionality between unbalance and vibration and partly to errors in amplitude readings. The points a, b, c are then shifted around, in the same way as in Fig. 3, but to a larger degree so that the strap II' will register approximately the right pinhole at u_o and still allow the pins a, b, c to be nearly on the same circle. The errors are automatically averaged up in this way between the observations of the various runs. This flexibility is one of the main advantages of the mechanical instrument over a geometrical construction by trial and error which could be used to solve the unbalance. It should also be noted that the mechanical method of construction can be completed in much shorter time and without the use of drawing instruments.

Unequal Trial Weights

It is not necessary to take equal trial weights for the three trial runs. If different weights are chosen, say q_1, q_2, q_3 in holes 2, 16 and 13, respectively, the points u_1, u_2, u_3, Fig. 2, would not be taken on a circle with $u_oa = u_ob = u_oc$, but these lengths would be taken in the ratio of the trial weights in the respective holes. The construction shown in Fig. 5 is used in this case. Making $u_om = q_1$, $u_oh = q_2$ and $u_or = q_3$, a series of lines are drawn parallel to the heavy line mhr. The lines a_1, a_2, a_3 must be drawn so that the points a, b, c would fall on the same broken line abc.

TABLE II—LOG OF BALANCING WITH UNEQUAL WEIGHTS

Run No.	Trial Weight, Oz.	Holes	Amplitudes, In. Coupling End	Amplitudes, In. Thrust End
1	None	.....	0.0029	0.0025
2	23	20 and 1	0.0020	0.0023
3	23	4 and 5	0.0016	0.0015
4	23	2, 3 and 4	0.0011	0.0012
	Applied Unbalance Finder			
5	28	3, 4 and 5	0.0003	0.0005
	18	2		
	10	1		
	Further balancing done on thrust end.			

Fig. 6 shows a computation of the correction weight in the case of unequal trial weights. A turbine spindle running at 1,800 r.p.m. was balanced. It had 20 holes in the balancing ring, Fig. 7, on the coupling end. The log of the balancing is given in Table II.

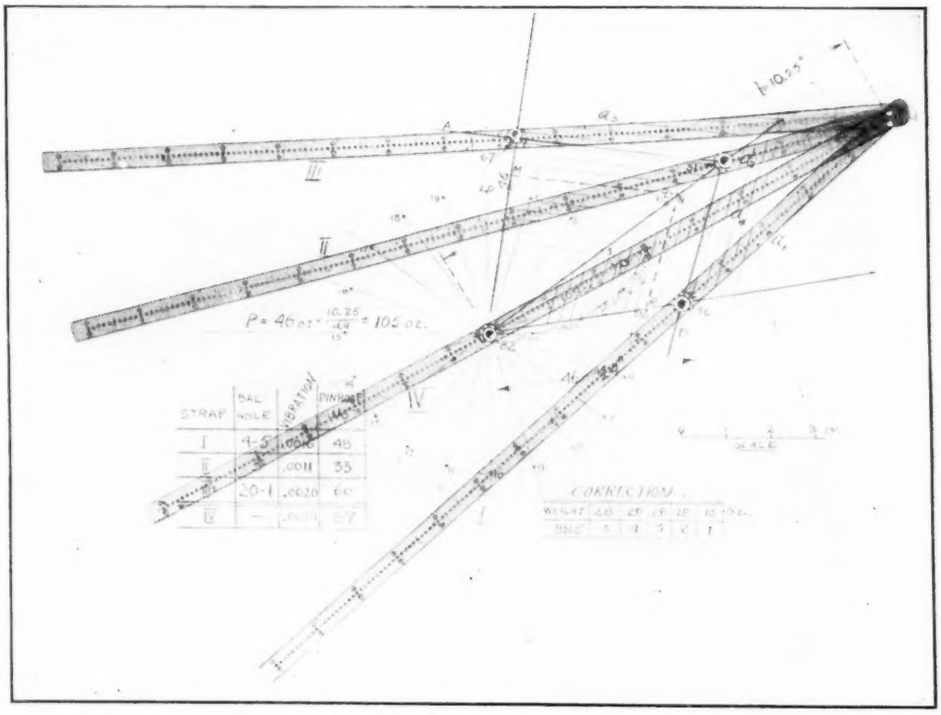


Fig. 6—Application of unbalance finder when using unequal trial weights

The computation of the necessary correction weight for this case is shown in Fig. 6. A series of lines parallel to the line MNR, takes the place of the circles in Fig. 3.

In the rest the procedure of computation is analogous to that described in the case of equal trial weights.

Procedure of Balancing a Rotor

It was found impractical to attempt balancing a rotor at both ends simultaneously. The mutual interference of the vibration of the pedestals transmitted from one to the other through the foundation and housing of the machine is too complicated to be successfully analyzed.

It is the practice therefore to balance each end separately. After a certain amount of experience, an engineer is able to determine by observation of the conditions of running, by the interrelation between the horizontal and vertical vibrations at both bearing pedestals, by the shaft markings and so forth, at what end of the rotor the unbalanced forces are larger. Records of the variation of the amplitudes of vibration while coming up to speed when starting the machine, give also a clue to the location of the main unbalanced forces. Naturally, every type of machine has its individual characteristics, and it is impossible to lay down definite rules for interpretation of vibrometer and other observations. It seems practical to start balancing the heavy coupling end of a turbine spindle or the end showing the largest amplitude of vibration in case of a turbo rotor.

The shaft is scribed at full speed and the position of the "high spot" is found after the rotor is stopped. The approximate location of the correction weight is known, as a rule, for every type of machine with respect to the high spot.

The trial weights are put into the balancing holes in the vicinity of this presumable location. It is advisable to place the weights in positions from 30 to 45 deg. apart

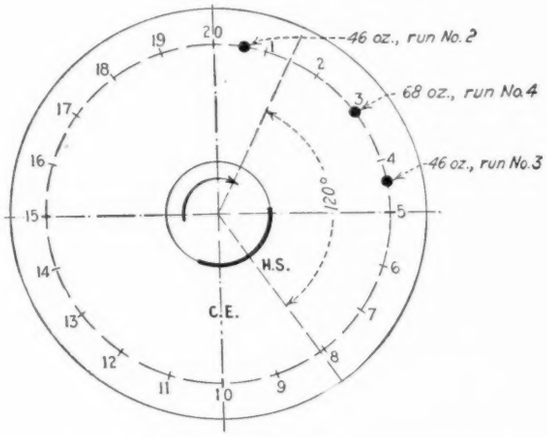


Fig. 7—Balance ring showing location of unequal trial weights

for the consecutive trial runs. A marked advantage of the method of unbalance computation already described is the ability to place all trial weights in the region opposite to the original unbalance. The trial runs are therefore made under conditions of vibration more favorable than initially.

Care should be taken that the amplitudes are read when the turbine has reached a stable state of temperature and load. The speed of the machine must be as nearly identical as possible when the amplitudes are read on the vibrometer dials.

The necessary correction weight is computed, and when the vibration of the worst end has quieted down, the other end may be balanced by the same method. It should be noted, however, that it does not pay to apply the unbalance finder in balancing a rotor with very little vibration of the pedestals, say, with amplitudes below 0.001 in. The inaccuracy of observation in this case would be of the same order as the values observed. Balancing in this instance will probably be a refinement

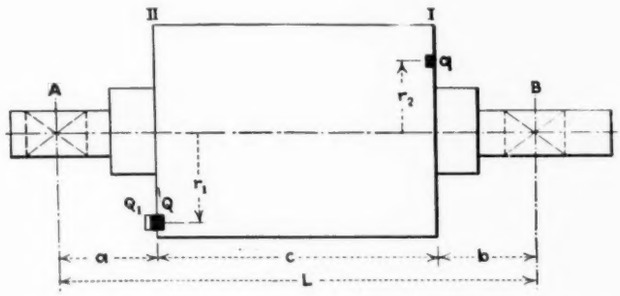


Fig. 8—Method of placing balance weights for end II after end I has been balanced

beyond commercial needs and should be done by cut and try. (Scribing the shaft in this instance does not give any reliable indication of the probable location of the correction weight.)

Placing a correction weight in the end *II* of a rotor, after the end *I* was balanced may disturb the conditions at the pedestal *I*, and this pedestal will vibrate again. To prevent this, the correction weight Q, Fig. 8, found to be necessary for the end *II* is replaced by a combination of two weights: Q_1 instead of Q in the end *II*, and a small weight q at the end *I*, placed on the side opposite to Q. The values of Q_1 and q depend on the distance c between the balancing rings and the distances a and b of the balancing rings from the bearings A and B, the dimensions being as shown in Fig. 8. The values of Q_1 and q are $Q_1 = Q \times \left(1 + \frac{ab}{cL}\right)$, and $q = Q \times \frac{a}{c}\left(1 - \frac{a}{L}\right) \times \frac{r_2}{r_1}$, where r_1 and r_2 are the radii of the balancing rings at the ends *I* and *II*, respectively. These equations are obtained from the consideration that the combination of unbalanced forces due to Q_1 and q would produce a moment with respect to B equal to that of Q alone, at the same time having a moment equal to zero with respect to A.

The method of balancing described in these pages has been used in service for a long period of time and has proved to be successful. Its application is so simple that every operator could probably use it with a fair amount of success.

However, it is understood that vibration in machines may not always be cured by balancing of the rotor. Sometimes a cure may be effected by making some slight change to the foundation on which the machine is supported, or by checking over the alignment of the bearings. A vibrating machine should be considered as a sick organism, quite complicated in its constitution, and it will, no doubt, always be advisable to consult a vibration expert, who will be competent to diagnose and prescribe a proper cure.

Modernization vs. Executive Resistance—IV

Mr. Bliman Takes the Count

COME right in Joe—I haven't seen you for quite a time; you knew I'd been away on a trip for a couple of weeks, didn't you? No, not a vacation exactly, though it did me a lot of good. I went around a whole lot of these fine up-to-date mills and public utilities where they have all the latest lines of power house equipment, and I tell you, Joe, they've got it all worked out down to the last ounce of coal.

You know I've always been great on science and modern methods and I believe in being up to date though conservative, and for a long time now I've been studying these new ways of getting power for nothing, more or less, and I've been encouraging my chief engineer, who has some pretty good ideas himself, to learn all he could about the new methods.

"You know I've always been great on science and modern methods"

What, you don't think I've been very encouraging to him so far? How can you talk like that, Joe? You know how I'm all for modern methods, and inspirational talks, and do all the business you can, and besides it don't do to rush things too much at first, but when that darned Ideal Mills started to get busy and soak up my business like it was a sponge, I figured it was time to sit up and take notice.

Well, it's the truth, Joe, I'd been thinking about it long before that and I've been discussing it with Jim for the last twelve months, as you may have heard me say, and then I sent him on a tour round some of these plants to see how they liked it now they've got it. Why, yes, it was his vacation, in a way, and he took his wife with him, and never mind if I paid him for going, that's my business, and if I didn't I'm going to make it up to him later; the point is that he saw these mills and came back with a mighty good tale, and so I decided I'd take a look myself; as they say, seeing is believing, although it don't always follow.

I saw two or three mills where they'd already got going and found it good business, like the Ideal Mills here, and several others that were getting their new plants built and near ready to run.

But what struck me most, Joe, was how everybody I went to see allowed they were figuring on a new plant along the same lines. I've never seen such a unanimous agreement among mill owners before, unless maybe it was on the subject of prohibition, and mind you, Joe, I ain't saying anything against it. It's a fine thing for the workingman, but when it comes to you and me, why it certainly is interfering with the liberty of the subject and I'm all for liberty, though I'd be on the water wagon myself just as I was before prohibition.

Seeing how things are with all of them, I've come to the conclusion that I'd better get in on the run without wasting any more time so we can get our plant built before the rush of orders swamps deliveries. I don't want to wait two years to get my plant running, and that's what it's going to come to, when the rush comes, and everybody wanting new plants built at the same time.

When I got back and told Jim what I had decided to do, he certainly was one pleased engineer. Of course, he wanted to let on it was all his idea and that I'd come round to his way of thinking, but I soon put him right on that. "You didn't invent high-pressure boilers did you, Jim? Nor yet extraction turbines, and if I hadn't employed you as my engineer, you wouldn't ever have suggested a new plant, would you?"

Well, he hadn't a word to say. He's a good lad and a clever engineer, but he don't know much when it comes to reasoning things out.

This point being cleared up and Jim put where he belonged, the next thing to decide was how I'd best get the job done. First of all, I thought we might get hold of one good boiler concern or maybe a turbine company and let them design us a scheme, but when I came to talk it over with Jim, I decided it wouldn't do to tie ourselves down in advance to one particular manufacturer even if we did save consulting engineers' fees by doing it.

It's wonderful what a lot of fresh ideas come to you just by discussing things with another man, no matter how dumb he might be, as I told Jim, and he told me he'd noticed the same thing.

The next thing I thought was maybe Jim could knock out a pretty good scheme and if we got plenty of figures and prices from the various equipment manufacturers, we could end up by having just the right plant to suit our conditions, because, after all, we know more about our mill than any outsiders we could bring in.

I thought Jim would jump at this, but he kind of hung back. "Well, Mr. Bliman" he says, "I'd like mighty well to design your new plant and I'm figuring to have quite a bit to say about it in collaboration, but I've done a lot of thinking about this thing, as you know, and while I could get up a good scheme to make good savings, yet I couldn't be sure I'd got the best possible scheme at the lowest cost, and where you're aiming to spend half a million dollars, you don't want to wake up when it is all complete and find you could have got as good results for a hundred thousand less, or maybe more savings for the same outlay. What I mean, in these new schemes there are so many different arrangements possible to do the same job, that unless you've traveled the road before, you're likely to make the wrong choice and not find it out till it is too late. That's where experience comes in, and that's why I think we should get some good, reliable firm of engineers, not tied in with any equipment manufacturers, who can work in with us, so as to use their experience of plants in general, combined with our special knowledge of our own plant, and thus view the whole proposition from an unbiased standpoint and get the one particular tailor-made plant that will best suit our conditions."

Well, I reckon he was right at that, and I'd have come to the same conclusion if I'd had time to think it over before he butted in.

So that's all fixed up, and now we've got to get busy.

Jim's one pleased lad all right, though he let out one wise crack I didn't quite get onto: "Well, Mr. Bliman, as the fans say, you've taken the count, at last."

INTERNAL COMBUSTION ENGINES

Arizona Edison Company Installs Diesels to Insure Service

Line Disturbances Cause Company to Install Diesel Engines —Hydro-Electric Power Will Be Discontinued—Operating Costs Expected to Be Under One Cent per Kilowatt-Hour

THE Arizona Edison Company serves Yuma, together with several other Arizona towns. Energy has been purchased from a transmission company having a hydro-electric plant several hundred miles away. As Yuma is the farthest south of the towns using power from these long-distance lines, the town suffered the effects of every line disturbance occurring between it and the generating station. Outages have been many; for example, in October there were 24 interruptions of service, the longest being of over three hours' duration. Owing to protests of the consumers, the Arizona Public Service Commission served an order on the Arizona Edison Company that it must improve its service. As there was no possibility of eliminating these line disturbances, the company has installed and is preparing to put in operation two 1,000-hp. Deisel generating units.

These are six-cylinder Werkspoore type four-stroke-cycle engines and were built by the Pacific Diesel Company, Oakland, Calif. They were manufactured during the War on a contract with the Shipping Board and at the close of the War were sold at public letting. The purchaser in turn sold them to the electric company.

Being marine engines, they were designed to carry light, small diameter flywheels, but for electric service were equipped with standard governors, and heavy flywheels were placed on the engine crankshafts just beyond the end main bearings.

Each of the 1,000-kva. General Electric generators runs at 150 r.p.m. and generates three-phase 60-cycle current at a potential of 2,300 volts. The shaft supporting the rotor is connected to the crankshaft by a flange coupling and is carried by two pedestal bearings. The 27-kw. exciters are mounted on extensions of the generator shafts.

The fuel will be a 28-deg. Baumé gravity distillate, which is procurable at $1.20 per bbl. delivered. In fact, it is quoted at a lower price than are the heavier grades. No heating of the storage tank will be done, as the oil is free flowing and Yuma has the reputation of being the hottest place in the United States.

Two service tanks are mounted high up inside the

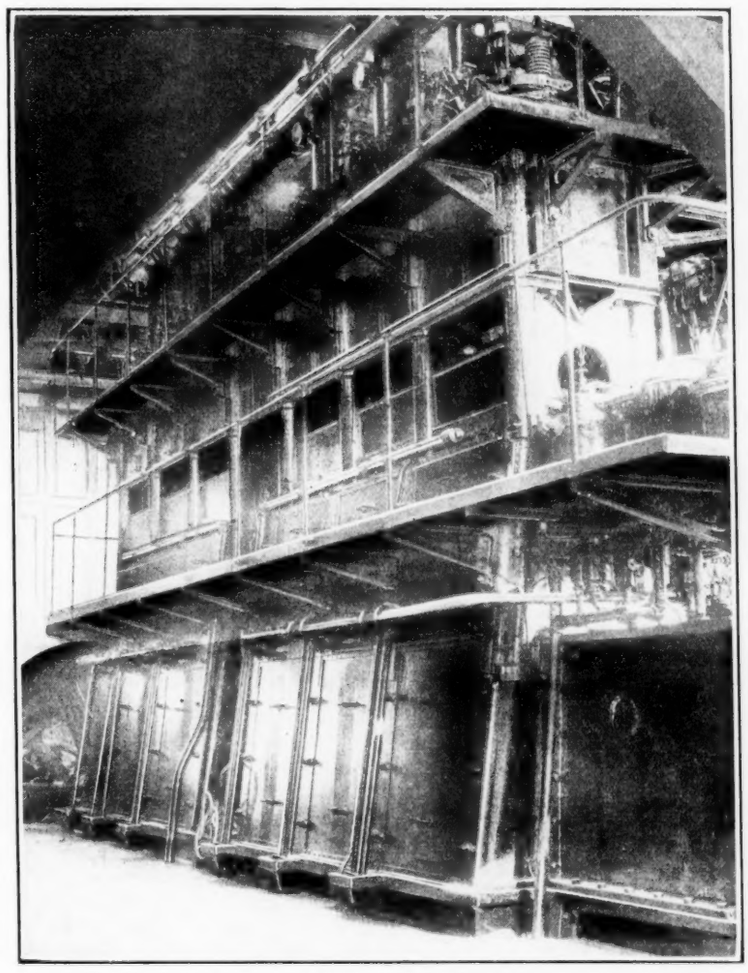


Fig. 1—One of the 1,000-hp. Diesels installed at Yuma

INTERNAL COMBUSTION *Engines*

building walls and are served by a motor-driven rotary pump.

The lubricating oil piping is arranged so that the oil, after dripping into the crankcases, flows to two rectangular tanks placed in a sump between the two engines. From these tanks it is lifted by a motor-driven 1-in. centrifugal pump to the clean-oil tanks placed against one of the building walls. A centrifuge is connected by

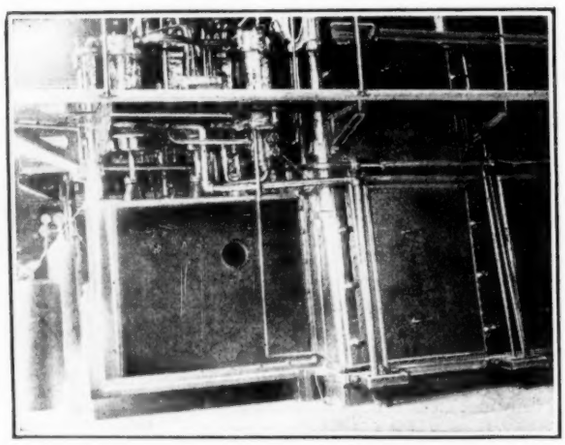


Fig. 2—The three-cylinder compressor is mounted at the end of the engine

a bypass to the oil tank, and the oil from the overhead tank when dirty will be put through the filter.

The lubricating oil sump tanks have no cooling coils. They are surrounded with the cooling water leaving the engine, and it is assumed that the water will hold the oil temperature as low as 120 deg. F. However, the summer temperature of the river is often as high as 120 deg. and the outlet jacket water will probably exceed 140 deg. F. in summer; consequently, there is reason to believe that the oil will be too hot and will require a better system of cooling.

Colorado River water carries entirely too much sand and scale-forming material to be used directly in the engine for cooling. A closed cooling system has been installed, in which distilled water will be circulated.

Cooling the Distilled Water

To cool the distilled water, a water-works type condenser will be used. This was formerly connected to a steam-driven plunger-type water works pump. Since the raw river water would throw down a large amount of silt as soon as it had come to rest, the engineers deemed it advisable to pass the distilled water through the shell and to put the raw water through the tubes.

The raw water will be hauled by an 8-in. double-suction Goulds centrifugal pump, having a capacity of 1,000 gal. per min. The cooling water will absorb about 4,200 B.t.u. per horsepower-hour, and with a temperature rise of 8 deg. in the raw water the condenser or water cooler will require 8,750 lb., or roughly 1,000 gal. per minute.

The company operates the water-works plant, and it is the plan to allow the raw water passing through the cooler to enter the water-works settling basins. The water will lose its extra temperature by the time it passes through the filter beds and enters the water mains; the advantage is that the generating plant will obtain its raw water without a pumping expense.

The distilled water is to be handled in an unusual way. The foundation of each engine is 27 ft. wide, 54 ft. long and 8 ft. deep, and rests on a concrete slab extending under both foundations. The space between the two foundations, which is 8 ft. wide, is sealed at both ends to form a water reservoir, a part of which is shown in Fig. 5. This outlet water from the cylinder jackets enters this pit through 6-in. pipe lines which extend to within a foot of the pit bottom. To handle the water, two 2-in. motor-driven centrifugal pumps are mounted on a frame in the pit and immediately under the floor plates. The water is lifted about two feet and forced through the coolers and back into the engine cooling system. As the amount of water in the system is fixed and the coolers will be below the pumps, there is no danger of the sump's flooding. As has been stated, the lubricating oil pump tanks are in this water reservoir.

To provide the makeup, distilled water that will be necessary owing to the usual small leakages, a waste-heat boiler is being installed. This, as will be seen from Fig. 3, is a 1,000-sq.ft. locomotive-type fire-tube. The exhaust pipes from the two engines will enter the firebox through the two openings shown in the concrete base.

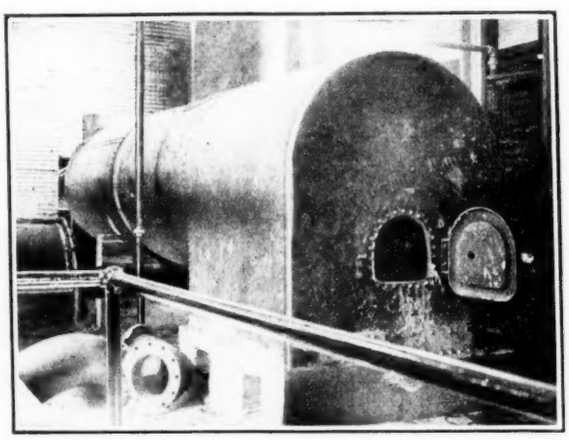


Fig. 3—A waste-heat boiler is installed

After passing through the tubes, the gases will exhaust through Maxim silencers. The plant is in the congested part of the town, and an absolutely noiseless exhaust is imperative. In order to insure a high gas velocity, about half the boiler tubes will be stopped up by plugs. It is the intention to arrange bypasses on the exhaust lines so that the gases from one or both engines may be passed around the boiler.

The steam generated by the boiler will be passed into the water reservoir to be condensed. It is not expected that the boiler will need to be operated more than a small portion of the time.

INTERNAL COMBUSTION *Engines*

The engines are unusual in that the air compressor is made up of three separate single-acting cylinders placed upon an extension of the engine housing, as shown in Fig. 2. The valves are all in the heads, making their removal easy. The three-throw compressor crankshaft is bolted to the end of the engine crankshaft.

The air is stored in three 30-in. by 8-ft. starting tanks at 250 lb. pressure. The high-pressure stage discharges into the injection-air tank placed in the center of the engine and cooled with the cylinders.

To insure air in case that compressed by the engine compressor is lost, a small three-stage Rix air-cooled compressor driven by a 5-hp. Newway gasoline engine has been installed. As will be seen from Fig. 4, even in October Yuma is so warm that an electric fan is needed to insure cooling of this compressor.

The company, as has been stated, operates the water-works system for the town. Owing to the unsatisfactory electrical service, the City Council has always insisted that a boiler be kept under steam to insure water in case of line disturbance during a fire. The fuel oil necessary to maintain a head of steam amounted to many hundred barrels per year. Although steam could be raised in 30 minutes, this could be done only if there was enough steam to atomize the fuel; the boiler, then, had to be kept under pressure at all times. The new superintendent, F. P. Smith, evolved the idea of using air for the oil atomizers. On a test, steam was raised to 125 lb. in 30 minutes and the pressure in the three large air starting tanks of the oil engines dropped less than 10 lb. This oil burner has been reconnected to the air line, and an old compressor, belted to a motor, has been connected up to supply the air until the engines are in operation or in the event that the engines should fail. The cost of the alterations was too small to be calculated, as all piping and connections were taken from the scrap pile. The yearly saving is equivalent to a return of 10 per cent on $6,000.

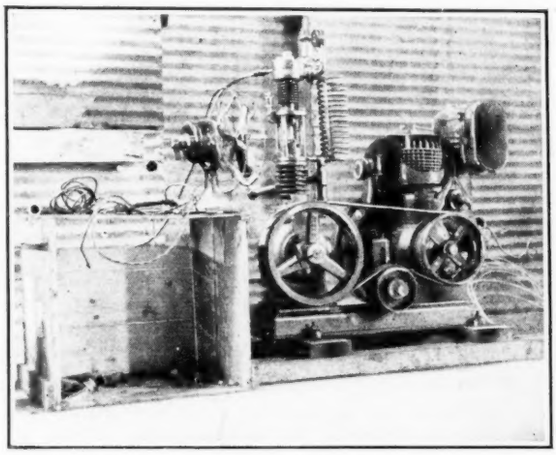


Fig. 4—A gas-engine drives an auxiliary compressor

If the waste-heat boiler proves suitable, it should recover about one pound of steam per engine horsepower per hour; with the two engines at full load it will return 2,000 lb. an hour. After deducting the several amounts needed for makeup, the remainder will be used in the gas works, also operated by the company.

The management has no criticism to make of the transmission line, from which the energy is now purchased.

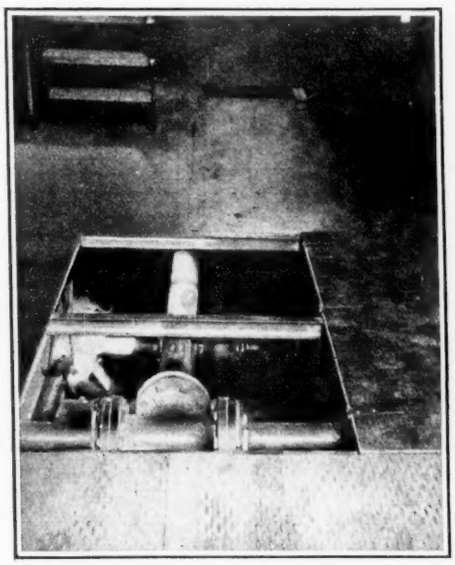


Fig. 5—A water sump is placed between the two engines

It understands that being at the extremity of the line, more line disturbances are experienced than elsewhere.

Results from Supercharging a Diesel

THE Brazilian motor ship "Itape," recently completed by Wm. Beadmore & Co., England, is provided with two four-stroke-cycle Beadmore-Tosi Diesel engines having a total rating of 3,600 b.hp. when supercharging is employed. Each engine has six cylinders 26-in. bore by 43.25-in. stroke; these are supercharged by a 13,700 cu.ft. turbo-blower driven by a steam turbine.

On its heat tests the engines were run both with and without the supercharging in commission. The results on an hourly basis are given in the tabulation.

	Without Supercharging	With Supercharging
Average speed, knots	14.1	....
Indicated hp.	4,370	4,780
Brake hp., deduced from torsionmeter	3,320	3,625
R.p.m.	133	137
Exhaust gas temperature, deg. F.	850	860
Blast pressure, lb. per sq.in.	900	900
Supercharging pressure, in water	....	25
Fuel oil used, lb. per hr.	1,450	1,481
Fuel per indicated hp. per hr. (main engines), lb.	0.327	0.31
Fuel per brake hp. per hr. (main engines), lb.	0.43	0.407
Boiler fuel used in boiler for auxiliary purposes per hr.	700	1,012

Over a measured mile unit the vessel was driven at full power. The engines developed 5,400 hp., of which 4,035 was delivered to the propeller shaft. The exhaust temperature averaged 900 deg. F.

ELECTRICAL *Operation and Maintenance*

Features to Consider

When Selecting Motor Controllers

By W. H. COSTELLO

Engineer, Cutler-Hammer Manufacturing Company

THE same tendency toward standardization and simplicity that has been manifest in many branches of the mechanical equipment, has likewise prevailed in the field of electrical control. Features listed ten years ago as optional, such as overload protection inclosing cases, are now practically standard and considered essential in the equipment. As might be expected, standardization has resulted in greater production efficiency so that the additional features included as standard have added little if anything to the selling price.

When one looks over a manufacturer's catalog or bulletins, there will probably be found notes such as "E.P.C. 35." The significance of this note has an important bearing on the subject of standardization, and it is desirable to make clear how a design engineer is guided and the interest of the user kept in the foreground when a standard controller is put on the market. The initials E.P.C. stand for the Electric Power Club, an association whose members are engineers and executives from the leading manufacturers of electrical equipment in the United States and Canada, and which is now consolidated into the National Electrical Manufacturers Association (NEMA). One of its accomplishments has been the defining and classifying of terms and phrases so their meaning will be clearly and definitely understood. For example, the term "E.P.C. 35" means that the controller to which it refers is designed for a starting-current inrush of 150 per cent full-load current for a period of 30 seconds once in four minutes. This does away with the ambiguous terms, light, heavy and frequent, which were at one time in vogue.

Likewise, the N.E.M.A. has defined the meaning of the terms weatherproof, dust-tight, low-voltage protection, low-voltage release, and any question of doubt regarding such terms can be quickly settled by referring to the N.E.M.A. specification. A summary of the principal definitions is given in many of the catalogs issued by controller manufacturers.

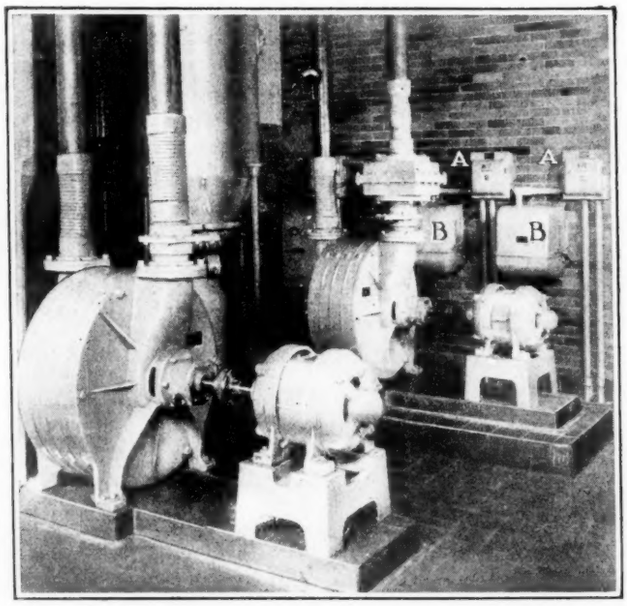


Fig. 1—Safety-type switches at A and compensators at B for starting vacuum-cleaner motors

Another agency of national importance is the National Board of Fire Underwriters. That agency issued booklets outlining the broad requirements of equipment for various classes of service. Affiliated with the National Board of Fire Underwriters is the Underwriters' Laboratories, which make the actual tests on the apparatus after construction. If the apparatus is approved, a card is issued, copies of which are sent to all of the local boards of the National Board of Fire Underwriters throughout the country.

The Underwriters' Laboratories determine, for example, whether the temperature rise of contactors, coils and resistors is within the recognized limits, as well as the arc-breaking capacity and other important factors. When a controller passes the approval of the Underwriters' Laboratories, a user may be reasonably assured that it is conservatively rated in every respect. For example, in the case of an across-the-line starter for a squirrel-cage motor, it will be determined not only whether the contacts will not overheat on normal current, but whether the contacts will safely break the arc with the motor stalled at full-line voltage. This point might not occur to a user in considering the purchase of a controller, but it is indicative of the precaution observed by leading manufacturers in the interest of the national industry.

INCLOSED OR OPEN CONTROLLERS

Most of the earlier types of motor controllers were open or partly inclosed. In modern designs many of them are totally inclosed in a sheet-iron or cast-iron case.

ELECTRICAL *Operation and Maintenance*

brought the latter type of protection into popularity, and most of the new starters, even for small motors, now use overload relays in preference to fuses. When the cost of fuse renewal is considered, the initial price of overload relays could, on the basis of economy, be appreciably higher than choice as to the preferred type of protection. Another factor is the time lost when fuses blow. While it might be said that a plant should always have a sufficient quantity of fuses or refills on hand to prevent delays, it is a fact that frequently the right fuses are not at hand.

Reference is here being made to the ordinary condition of stopping due to motor overload, and it is not intended to mean that fuses are not a wise provision in the line. In fact, the use of an inclosed knife switch with fuses would not be sufficient to harm the motor, will not trip the thermal overload if the latter is properly adjusted. On the other hand, an overload condition that persists long enough to raise the temperature of the motors to a dangerous value, will cause the overload relay to function and open the motor circuit. On a hot day it would require a relatively smaller overload to open the circuit than on a cool day, and this feature also protects the motor, its overload capacity being less in a high air temperature than it is in a low air temperature.

To function properly, the thermal overload relay should be working under surrounding conditions similar to those of the motor. That is, the air temperature in the room where the controller is mounted should vary the same as that of the motor room, otherwise heating

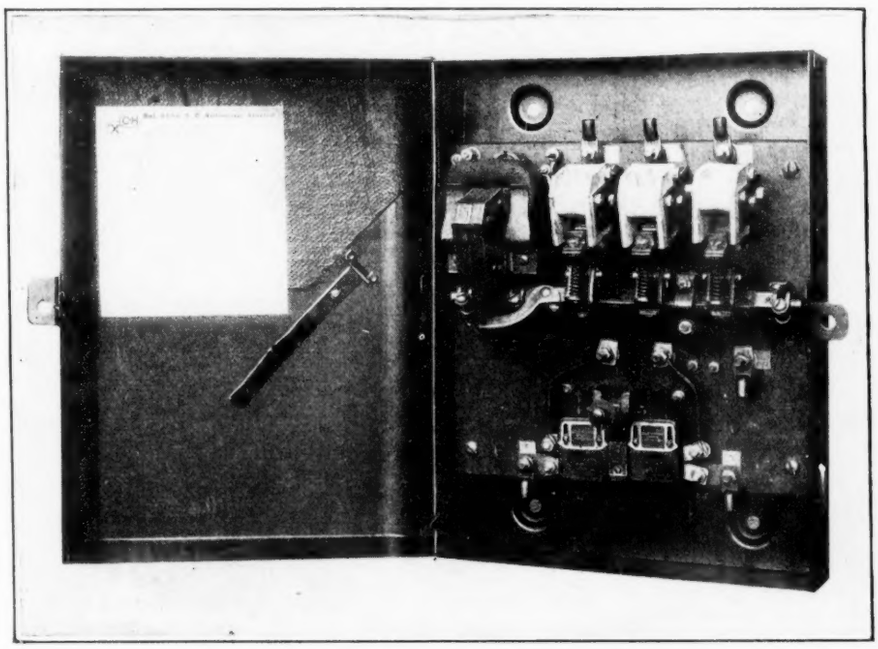


Fig. 4—Totally inclosed across-the-line induction-motor starting switch with thermal overload relays

Fig. 5—Inclosed circuit breaker and speed regulator

ahead of the controller is recommended and quite universally practiced. The overload relays take care of the ordinary overload stopping with very little loss of time and at no expense, while the fuses are there for any abnormal condition that may arise.

Overload relays are generally of two types, thermal and magnetic. The popular low-priced relay of today is the thermal type. Mechanisms vary, but they all work on the principle of heating of the overload coils causing the control circuit to open and the switch to drop out. A single overload can be used for direct-current and two overload elements for polyphase alternating-current circuits.

An outstanding advantage of the thermal overload relay is the fact that the heating of the overload element follows the same law as the heating of the motor. An overload condition maintained for a short time, which conditions of the two will not be comparable. Also, if the controller is adjusted for running while inclosed, the cover should be kept closed. The same provision for maintaining constant operating conditions for the motor should be maintained for the controller, and the relation between the two will remain fixed.

Magnetic overload relays are caused to function by the current taken by the motor, just as are the thermal types. The heating of a motor varies as the square of the current, and, theoretically, the magnetic action of the overload relay should vary in a similar manner. Owing to saturation of the magnetic circuit, however, the force tending to close a magnetic-type overload relay does not follow the same law that governs the heating of the motor. Furthermore, magnetic overload relays are not affected by ventilation or temperature of the surrounding air, but by the current in the motor circuit only.

ELECTRICAL *Operation and Maintenance*

Inclosures serve three purposes: (1) To protect the operator; (2) to protect the controller; (3) to protect surrounding apparatus.

From a chronological point of view these functions were developed in reverse order. The fire insurance underwriters required the inclosure of the resistors to prevent fires. This inclosure also protected the resistor from external injury. Protection to the operator has come into the picture comparatively recently, because of lower premiums for Worker's Compensation Insurance and other reasons.

Inclosed controllers are now practically the rule rather than the exception, and because of improved designs and greater quantity manufacture of inclosed structures, the price question is no longer a factor of importance. In fact, many starters for standard moderate-sized motors are offered in the inclosed structure only, because no price advantage could be shown in the open-type starter.

Incidentally, "semi-inclosed" is a better word than "open" to describe some controllers, because the resistor at least is inclosed. The word "inclosed" infers complete inclosure, not only the resistor but the front.

Inclosed Knife Switches

It has been rather common in the past to supply inclosed knife switches and fuses as part of the control panel, but it is now customary to make the knife switch a separate device. There are a number of approved, inclosed quick-break knife switches with fuses on the market and carried in stock by dealers. Contractors can supply these switches conveniently from dealers' stock. Price as well as other considerations dictate the use of a separate knife switch, and many starters formerly listed with and without knife switches are now listed without any option as to the knife switch.

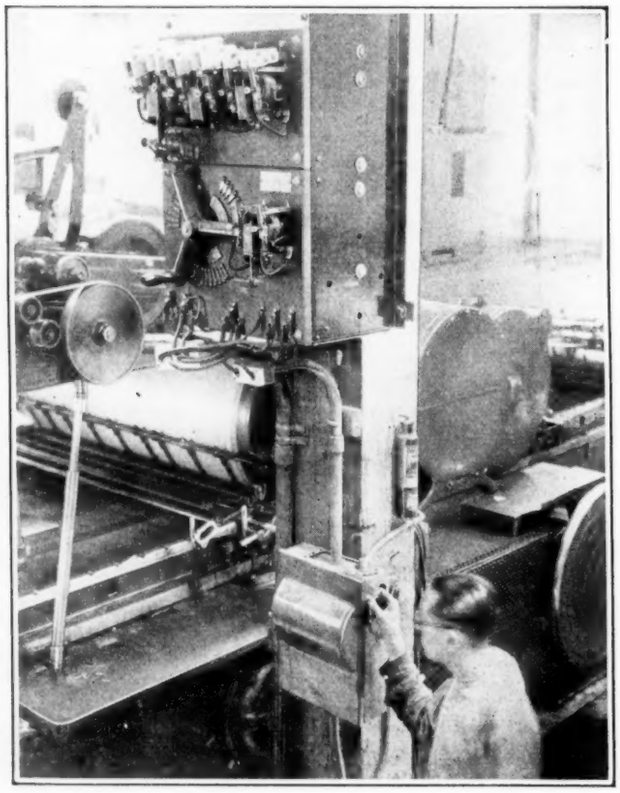


Fig. 2—Totally inclosed switch and semi-inclosed controller mounted on building column

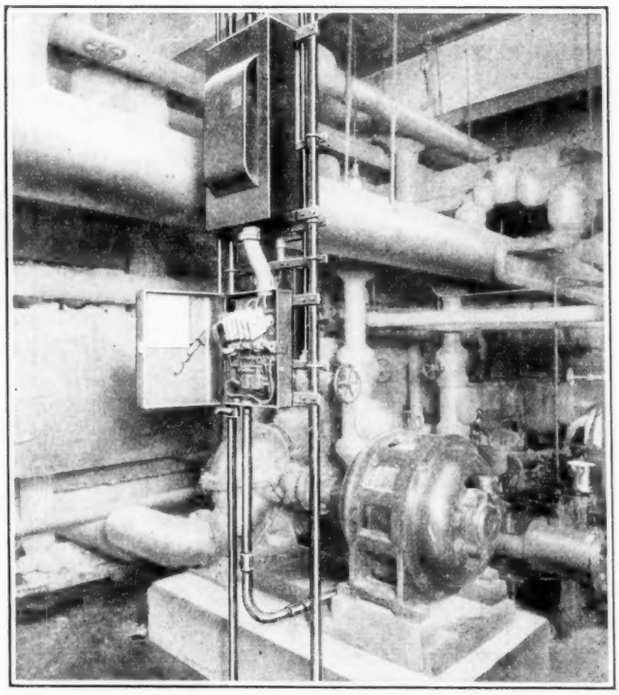


Fig. 3—Fused safety switch and inclosed controller mounted on pipe-work structure

Oil Switches and Air-Break Switches

For low-tension work air-break switches are used in preference to oil switches, which were quite common in the past. This condition has been brought about by the greater efficiency of blowouts and arc shields. Air-break switches are simpler, take up less space and have a lower first cost. Even for potentials as high as 2,200 volts, where oil switches have been used exclusively, magnetic air-break switches are sometimes used on automatic starters. The principal function of the oil in an oil switch is to quench the arc, and when equivalent results can be obtained by air-break switches, the latter type is generally the most economical.

The majority of switches for 2,200 volts and everything for higher voltages are still of the oil-break type for the reason that at these voltages oil is the best means of quenching the arc.

Fuses and Overload Relays

For protection against short circuits or overloads on the motor, either fuses or overload relays must be used. Because of the lower first cost on small equipments, fuses have for a long time been commonly accepted, but the development of low-priced overload relays has

ELECTRICAL *Operation and Maintenance*

There are two types of magnetic overload relays in general use on motor controllers—the instantaneous and the inverse-time limit. The instantaneous overload will open the circuit on an overload condition of short duration, whether or not the overload is sufficient to cause overheating of the motor. An instantaneous trip overload of this kind effectively protects the driven machine and is used on installations where the machine is subjected to jamming, such as a crusher or conveyor. For machines of this type it is desirable to disconnect the motor as quickly as possible when the overload condition occurs.

The inverse-time limit overload is designed to work against the action of a dashpot, and the time of opening depends upon the degree of overload. For example, if the motor is overloaded 100 per cent, the overload will act in one-quarter of the time that it would take for an overload of 50 per cent.

Obtaining Winding Data When Rewinding Motors

WHEN rewinding motors it is essential that sufficient data be taken from the old winding to connect the new one in the same way. If this is not done, it may be extremely difficult to connect the new winding in the proper manner. It is probable that the only way that it can be accomplished is to send to the manufacturers of the machine for a connection diagram. To obtain this it is necessary to give the nameplate data on the motor.

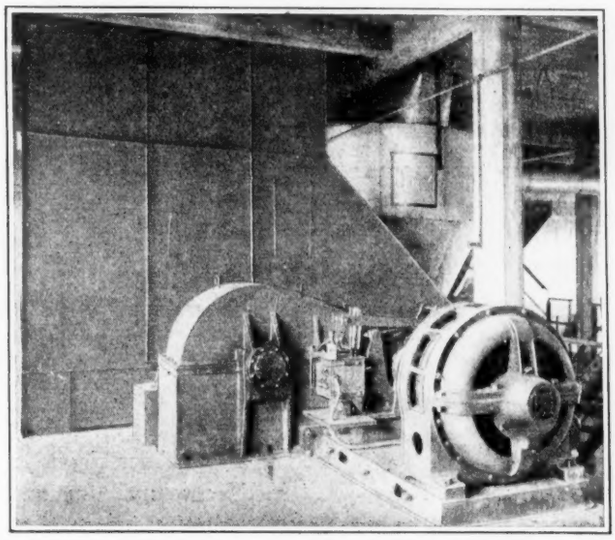
There is literally no end to the number of motor-winding connections. For example, for two-phase and for three-phase motors, for winding in two-pole to fourteen-pole motors, there are different standard groupings of the coils. There are twelve standard ways in which a twelve-pole winding may be grouped to operate in a three-phase motor. Any one of these methods may be used satisfactorily if the winding is designed for that particular grouping.

In general, when a winding is designed for one grouping and voltage, no other grouping can be used for the same voltage; therefore it is evident that knowing the number of coils in the winding and the number of turns per coil is not sufficient information to rewind the machine.

In direct-current machine windings the number of poles will determine quite closely the number of slots spanned by a coil. This, however, is not true with alternating-current windings, since the coils may be chorded to where they span about one-half of a pole space. Then, again, the grouping of the coils after they are in the slots must be considered. They may be connected in delta or in star, with series or parallel groupings of the pole-phase groups in various combinations depending on the number of poles in the machine. The correct grouping was determined by the designer and used in the original winding.

High-Torque Motors Permit Large Savings

SAVINGS estimated at approximately $100,000 are expected by the Philadelphia Grain Elevator Co. as the result of the installation of high-torque, high-reactance, squirrel-cage induction motors for driving the machinery of its new export grain elevator at Port Richmond, Philadelphia, Pa. These savings will be brought about by obviating the over-motoring necessary when using standard squirrel-cage induction motors, as has been customary in the past. The motors and control



A 125-hp. motor with solenoid brake geared to a grain-receiving leg

equipment were furnished by the General Electric Company.

The various motor applications throughout the elevator require a total of approximately 5,000 hp. The usual custom in the past has been to use standard-type squirrel-cage induction motors for the various drives, but these motors require the use of compensators to limit the inrush current, and the use of compensators reduces the starting torque to an extent where it is necessary to over-motor in order to produce the necessary torque for starting the heavy loads found in this type of application. It is conservatively estimated that, using standard squirrel-cage induction motors, a total of approximately 7,500 hp. would be required.

By choosing high-torque, high-reactance, squirrel-cage induction motors for these applications, it was possible to eliminate the necessity for compensators and thus motor closely to the actual horsepower requirements. The actual installation involves a total of 164 standard and double-squirrel cage, 440- and 2,200-volt induction motors, ranging in size from $\frac{3}{4}$ to 200 horsepower.

Another innovation in grain elevator practice is the use of solenoid brakes instead of mechanical backstops on all the elevator legs. A total of 24 of these brakes is used on motors rated from 35 to 200 hp.

EDITORIALS

Train Industry Through Educational Orders

OF LATE the daily press has devoted much space to preparedness in connection with the proposed Naval program now before Congress and involving an expenditure of several hundred million dollars. These discussions, because of their more spectacular nature, have somewhat overshadowed the Army appropriation bill for 1928, also before Congress. The latter amounts to nearly four hundred million, of which a considerable part will be spent directly and indirectly in training personnel.

While the training of personnel is quite essential, it is also vital that some attention be given to the training of industry. The World War proved the latter to be a far more difficult task than the former. From April 6, 1917, to November 30, 1918, the total combined cash appropriations and contract authorizations for the Army and the Navy amounted to over thirty-seven billion dollars, of which eighty-eight per cent was for Army activities and only twelve per cent for Navy activities. Measured in dollars and cents, a single Army activity—ordnance—was in fact, three and a half times bigger job than the whole Navy job. Had more manufacturers possessed experience in the production of ordnance, much useless expenditure would have been saved and the period of getting into production greatly reduced, with perhaps a shortening of the conflict. In a future conflict this might be still more vital, for we probably would not have the productive capacity of allies to draw upon during the "tooling-up" period.

The importance of providing for proper Army Ordnance preparedness is obvious.

The industrial preparedness program, provided by the National Defense Act of 1920, under the direction of the Assistant Secretary of War, has progressed to a remarkable degree, but it is on paper only. Meanwhile, stocks of munitions have deteriorated in storage and much has been expended in routine practice.

Under the present law replenishment of these stocks can be and is being made only through the regular government arsenals. While it is true that the latter can manufacture more cheaply than private firms, because they have no fixed or administrative charges, it must also be remembered that the combined capacity of the arsenals would produce barely ten per cent of war requirements.

Secretary Davis has urged amendment of the present law to permit the placing from time to time of small educational orders with commercial concerns to whom schedules have already been allocated. This would involve very little increased expenditure, but it would enable the production departments of such firms to anticipate and solve the various problems involved in the manufacture of such highly specialized products during a period of leisure and not under the stress of an emergency.

The foregoing should not be interpreted in a militaristic spirit. It is the sincerest hope of Americans that reason will displace resort to arms in the settlement of future controversies. However, if a reasonable measure of preparedness is proper as an insurance—and Congress, by the National Defense Act of 1920, has seen fit to so regard it—then let the idea be carried out in the most intelligent manner possible, consistent with the least expense. The recommendations of Secretary Davis are constructive and warrant support.

While the subject may at first seem only remotely related to the field of *Power,* it will be recalled that many manufacturers of power equipment were called upon during 1917 and 1918 to produce war materials, and to many of these paper allocations have been made in the present program.

Changing Trends on the Pacific Coast

SOMETIMES one at a distance gets a better perspective of what is happening than one in the midst of things. This view may be applied to power development on the Pacific Coast. The early developments in that section were hydro-electric, and remarkable progress has been made there in bold hydraulic engineering schemes, in long-distance electrical transmission and in high-head hydraulic turbine design. Electric service to customers has been cheap, and its use has extended rapidly, so that extensive systems have grown to meet this demand.

With such extended systems outages are bound to occur due to generating, distribution, and transmission troubles. Customers are now demanding more reliability in service, and to meet this demand, to handle peak loads and to serve in emergencies such as a year of drought, the power companies in Southern California have already built large economical steam central stations.

In systems in the East where power was originally from hydro-electric sources, engineers have learned that under certain load and water conditions, it is more eco-

nomical to use the steam station of the system for base load and the hydro-electric plant for peaks provided there is pondage enough to store water. Apparently, similar conditions have developed in the West, for it is said that the plants in Southern California are operating for a portion of the time on base load. It is now reported that extensions are to be made to the steam stations of the systems furnishing San Francisco, where in all probability conditions similar to those herein referred to will exist in the near future.

There is much water power still undeveloped in the West, but as a rule the sites still available will prove more costly than those now built. On the other hand, the cost of power from steam is steadily decreasing. The harnessing of the Colorado River may alter conditions for a time, but this is a river with seasonal flow and with no large reservoirs for long-time storage, so that conditions will soon become similar to those now existing if power demands continue to grow.

The trend, therefore, seems to be toward the more extensive use of steam-generated power on the Pacific Coast. One can expect each successive addition or new steam plant constructed in that section to embody more and more of the modern refinements to secure high efficiency and to approach steadily base-load operating conditions. If the uses of electricity continue to grow at the present rates, it is not inconceivable that the ultimate trend will be toward large central steam stations for base load with auxiliary hydro-electric developments largely to meet peak demands.

The User's Part in Safety Grounding

GROUNDING of electric circuits is a subject that has been discussed from almost the beginning of the industry, and it is still attracting a great deal of attention. The fact that it was not settled long ago is good evidence of the many difficulties involved. To arrive at a satisfactory solution will require the co-operation of manufacturers, code-making bodies and users.

The final solution of the problem is with the users, since ground connections are not permanent unless they are properly maintained. Even if they are properly made at the time the electrical equipment is installed, many things can happen to destroy their effectiveness in a short time, if they are not given the proper attention.

Electric circuits and equipment are grounded for two purposes—to afford protection against fire and protection against electrical shocks. Both of these hazards are real as evidenced by many fires due to improperly made electrical installations and the fatal accidents that have occurred from the same cause. Recently, three men were killed in about the same number of minutes, by coming in contact with a portable coal conveyor. Such occurrences should be sufficient to impress the user with the importance of making electrical equipment and the apparatus to which it connects safe to work on.

Experience shows that by far the greatest number of accidents occur on low-voltage circuits and from the frames of equipment, neither of which is generally considered as possessing serious personal hazard. Under certain conditions voltages of one hundred and less have caused fatal shocks. This, however, is not the only hazard. There is always the danger of high voltages being impressed upon low-voltage circuits, such as break down between a transformer primary and secondary.

Most of these hazards can be eliminated by properly grounding the equipment and circuits and maintaining these ground connections in good condition. Maintenance is an important part of the whole problem. The ground connection is something that in most cases the equipment will operate as well without as with. Unless the maintenance of the ground connections is made a part of the regular equipment maintenance routine, the effectiveness of the grounds may be lost.

Interconnections

THAT interconnections have emerged from the realm of technicalities into a realm of common sense, is the opinion of Alex Dow, president of the Detroit Edison Company. Such a statement, from a man whose outspoken opinions on this subject are well known, has real significance.

Interconnection he defines as a connection between two systems permitting electric energy to flow in either direction, and such an interconnection is mutually helpful, convenient and profitable—helpful because it provides an additional reserve available during an emergency, convenient because it permits a better building program, and profitable because it permits better distribution of load.

The Detroit Edison Company has at present an interconnection with the power plant of the Unversity of Michigan that is operating to the advantage of both.

During the winter exhaust steam from turbines is used to heat the university buildings, and the electric energy produced by the steam passing through the turbine in excess of the local demand is delivered to the central station system. During the night, when the heating load is low, and during the summer, when no steam is required for heating, the central station system supplies the power demand. Thus, the University is saved the wasteful non-condensing operation of the turbines, and the central station is provided with a profitable off-peak load.

There are undoubtedly a large number of similar interconnections that could be made between industrial power plants and central station systems. It is hoped that the future will see an increasing number of such mutually profitable arrangements.

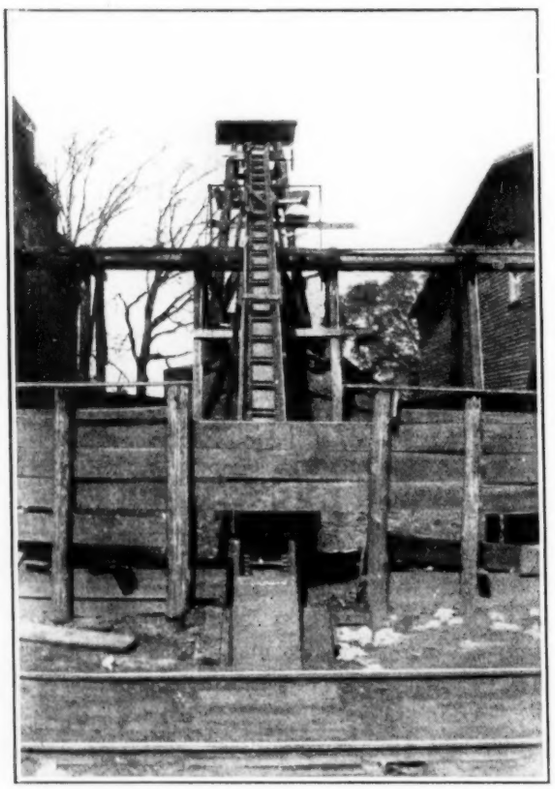
IDEAS *from* PRACTICAL MEN

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

An Improvised Inclined Coal Conveyor

TO FACILITATE the unloading of coal at our power plant, we built the inclined conveyor shown in the illustration.

A track was built alongside the plant to which the cars are switched for unloading. A pit was dug beneath this track and lined with concrete. Sprockets for an endless chain were then mounted in the pit and a hopper was erected above to direct the coal onto the chain. The conveyor is placed on the incline and terminates about 50 ft. from the track and 20 ft. above the coal bin. This affords ample space for the unloading of two cars or more without the chain being obstructed by the pile under the dump end. The conveyor is driven at the upper end by means of a belt from a line or countershaft in the plant, and when it is desired the chain may be stopped without shutting down the plant engine, by shifting the belt from the driving pulley to an idler placed alongside, a shifting arrangement being provided for this purpose.



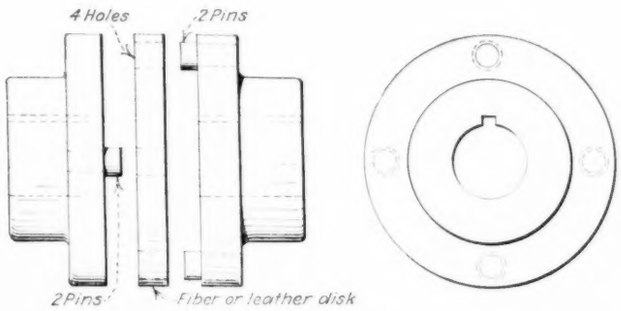
Inclined conveyor carries the coal from an unloading hopper to storage pile

The coal is received in hopper- or drop-bottom railway cars which are placed with the drop doors immediately over the pit, the doors being released with the chain in motion. A hinged cover made of lumber is turned down over the hole when the conveyor is not in operation.

Cairo, Ga. L. M. JORDAN.

An Inexpensive Flexible Coupling for Small Drives

BOLTED flange couplings are often a source of unsuspected trouble in lineshafts and motor drives, and not infrequently misalignment at the coupling causes heating and wearing down of the bearings with consequent rubbing of the armatures in the motors. Wherever this condition is noticed, a flexible coupling will often prove to be an effective remedy.



Detail of coupling

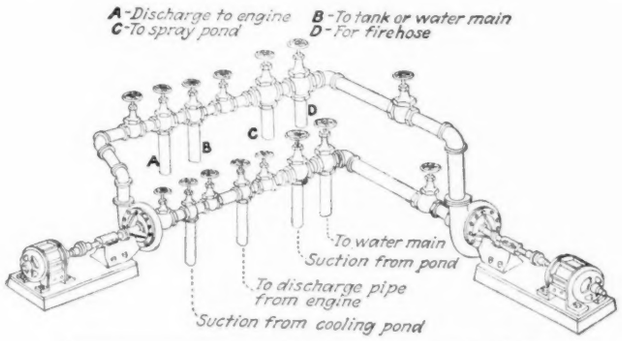
If a plain flange coupling has been used, it can be readily converted to a flexible one by inserting a disk made of leather or fiber between the flanges. For the heavier drives fiber is recommended. A pair of drive pins assembled on the center line near the outer edge of each flange serve to retain the disk in place. Four corresponding holes are drilled in the disk on the quarter lines. The drive pins are made with shoulders and should be a drive fit in the flanges of the coupling. The holes in the disk should be about $\frac{1}{32}$ in. larger than the outside diameter of the pins to prevent binding. Also there should be a slight end play between the disk and the two flanges. A coupling of this design will operate satisfactorily on small drives and compensate for any misalignment of the shafts. H. L. WHEELER.

Syracuse, N. Y.

Interchangeability of Pumps

Some plants are handicapped by certain valves being located in inaccessible places as well as by having certain pumps installed so that they can be operated only as independent units.

When the oil engine was installed in the Easthampton Plant of the Long Island Electric Company, care was



Arrangement of duplicate pumps and piping

exercised to arrange the piping and valves so that the two water pumps could be used together to perform the same work or independently to perform different work.

The plan adopted finally is shown in the cut. It will be readily appreciated just how flexible this arrangement is and how easily the pumps can be arranged for different operating conditions. J. E. BARRETT.

New York City.

Measuring the Amount of Water Discharged by a Mine Pump

AT ONE of our mines a 900-gal. centrifugal pump at the bottom of a 200-ft. shaft discharges water to a 1,200-gal. pump 100 ft. up in the shaft.

The larger pump discharged into a 12-in. pipe going to the top of the shaft and from there in a 45-deg. incline to the crest of an 80-ft. hill, then horizontally 200 ft. to a creek.

The lower pump was operated most of the time with the discharge valve about one-third open or just sufficient to hold the water level at the bottom of the shaft. This aroused a lot of arguing as to how much water was actually being pumped. Finally, the management decided to purchase a modern pump to be operated at the surface, so they gave orders to find out.

To do this, we erected a wooden tank 8x5x5 ft. at the end of the discharge line, on which we attached a 45-deg. elbow and a 6-ft. piece of pipe, the end being some inches higher than the edge of the tank.

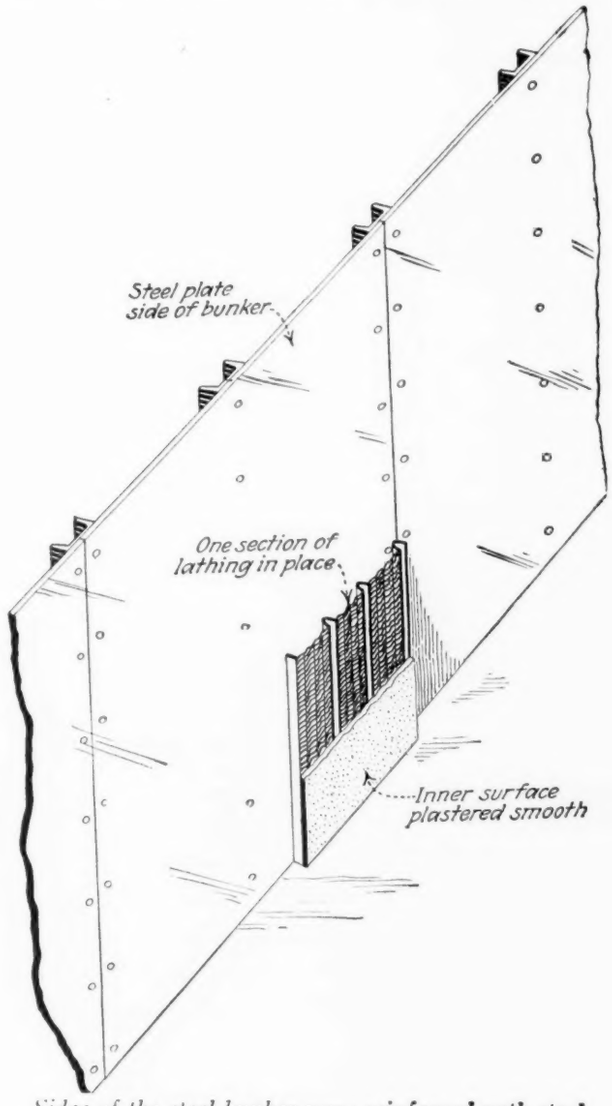
On the end of the piece of pipe was put another elbow with a short piece of pipe which could be swung to discharge the water into the tank or to the creek. We kept the tank flooded over night so as to insure against leaking while testing, which simply consisted in turning the upper elbow over the empty tank for a minute and then turning the water over the creek again. By doing this a few times a day, we could readily estimate the average number of gallons discharged, which in this case was found to be 650 per minute. AXEL LEKSTROM.

Ironton, Minn.

A Repair to Steel Coal Bunker

AT THE London Hydraulic Power Company, the steel coal storage bunkers began to corrode, and some kind of repair or replacement of the plates became necessary.

As replacing the plates would have meant considerable expense, it was decided to line the bunkers with reinforced concrete, using the "Hy Rib" steel lathing to support it. The main steel supports were in good condition, and the lathing was fixed to this and to the sound parts of the steel plates. When the steel lathing was



Sides of the steel bunker were reinforced with steel lathing and concrete

fixed, the space between the worn plating and the lathing was filled with a concrete made of one part cement and three parts sand, to which was added some long cowhair to act as a binder, one pound of hair being added to three cubic feet of concrete.

When the concrete had set, the outside was plastered smooth to protect the lathing and give a smooth surface exposed to the coal. The cost of this repair was about one-tenth that of replacing the steel plates.

Shefford, England. W. E. WARNER.

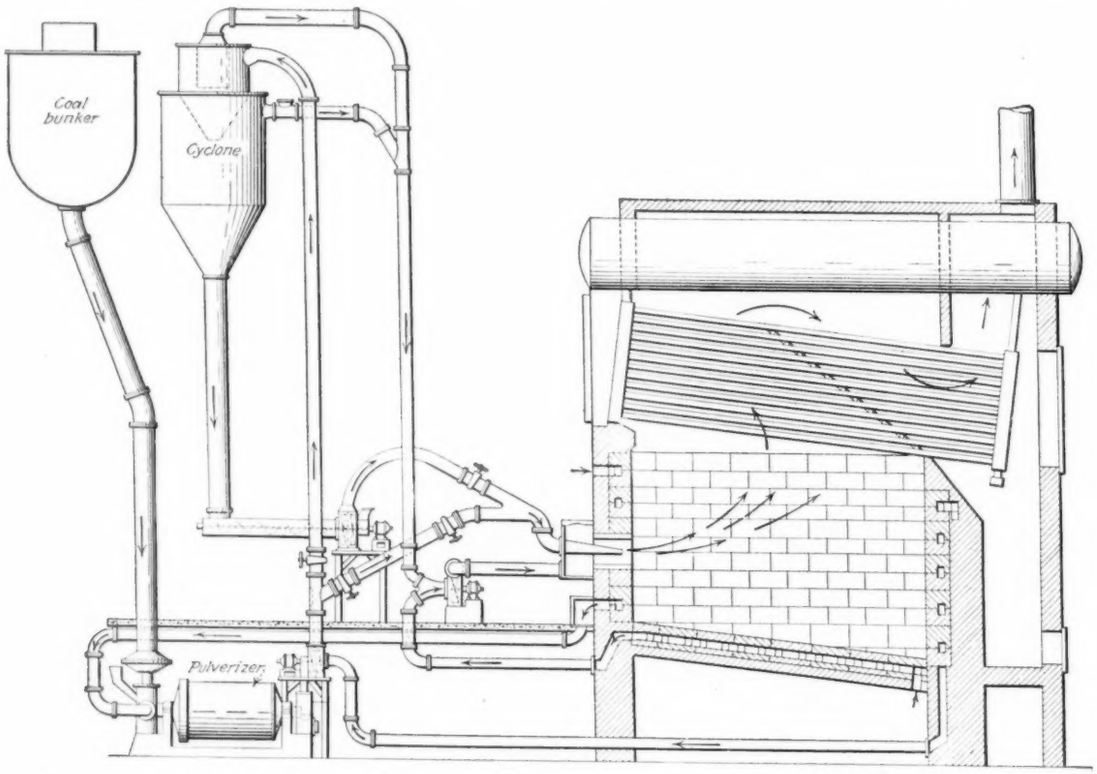
COMMENTS *from* READERS

Waste of Dust from Cyclones

THE editorial on "Coal Dust" in the Dec. 6, 1927, issue was of interest to me inasmuch as I have had patents pending for some time on reclaiming the air from the cyclone through a fan to the furnace as secondary air for combustion. With reference to the statements made in the editorial on the subject of dust explosion, there is another factor that apparently has been overlooked; namely, the deposit of the hydrocarbons in the pipe continually compressed under low pressure against the inside of the pipe, which forms the explosive mixture, and not the air and coal. Air floats have been returned to tube mills from cyclones and other types of grinding machinery for many years. The density of this returned air covers a broad field of mixtures and no explosions have been recorded. The Bureau of Mines has been working on this for many years. While they have made some determinations, it does not yet appear that they are final.

The accompanying illustration shows an arrangement that embodies some of the ideas brought out in the editorial.

J. E. KENNEDY,
Kennedy Van Saun Mfg. & Eng. Corp.
New York City.



Arrangement for reclaiming the air from the cyclone and using it as secondary air in the furnace

Steam Cylinder Oil for Diesel Engines

I NOTICE that in the Dec. 27, 1927, issue, Question No. 9 in the "What Do You Know" column, referring to steam cylinder oil for the lubrication of oil engines, was answered by the statement that such oil had been used successfully in a certain two-stroke-cycle type unit in Los Angeles with good results.

While such an oil may prove satisfactory to a certain extent, I have found from past experience with a great many units that the best possible type of lubricant for these cylinders is one that is thoroughly filtered and contains no heavy blended ends of cylinder stock or steam-cylinder compounds. After combustion takes place, or rather after the power stroke has been consummated, these blended ends will leave a hard deposit on the exhaust ports making the working of the unit inefficient.

In some water-injection type oil engines it has been found of advantage to introduce some animal or vegetable compound in the oil for the purpose of saponification, but in the ordinary type I feel that the operator is infinitely better off if he uses an oil particularly designed for the unit rather than one that is not created for this purpose.

N. H. STEINDLER,
Chicago, Ill. The Texas Company.

Guessing Fixed Charges for a Proposed Power Plant

THE expected cost of power from a proposed private plant is usually arrived at by dividing it into: First, operating cost, comprising expenses that vary with use, such as fuel, labor and repairs; and second, "fixed charges," consisting of unchanging items like interest, depreciation and obsolescence, that depend upon the useful life of the equipment.

This is in accordance with the principles of orthodox accounting and will yield the right answer, provided the percentages assumed for the fixed charges are substantially correct. But, unfortunately, opinions differ widely as to the percentages that should be prescribed, and sometimes, through a misunderstanding of the very meaning and purpose of fixed charges, a percentage is set down that does not represent fixed charges at all.

An example of such a misinterpretation is contained in a recent publication of the central station industry on the subject of Diesel Engine Power Costs. It was stated that business concerns will ordinarily require that any investment made in plant equipment must be returned in not more than five years. This was taken to mean that an annual charge of 17.7 per cent of the initial investment must be set up, which, with taxes and insurance, was said to make the total annual fixed charges approximately 20 per cent. The arithmetic is correct, but it has nothing to do with fixed charges.

It is true that the average business man wants any investment in new equipment, regardless of its real life, to be returned quickly, say in five years. He demands this rapid repayment of capital, not because he expects the plant's usefulness will be limited to that period, but on account of a natural desire to regain his funds after a reasonably short interval. In these eventful days the industrialist is entitled to refuse to tie up his capital for a long term of years.

But such a requirement is in no way related to fixed charges. The fixed charge method is intended to show the true annual cost of power based upon the *real* life of the equipment, and if for other reasons it is requisite that the plant pay for itself before it has worn out, an entirely different method of computing should be employed.

In such a case fixed charges should not enter at all, but, instead, the computation should show how soon the oil engine plant will pay for itself out of the savings over competitive methods. If this can be accomplished in less than five years (or whatever other period is imposed), the plant should be installed. Thus, the power user will be assured that his investment will be repaid promptly and that subsequently all the savings will be net profit. If, besides the reduction in cost, other advantages accrue, so much the better for the oil engine plant.

Take, for example, an industrial establishment using 17,000 kw.-hr. a month and having a maximum demand of 100 kw.; this would result from running 9 hours a day, 25 days a month, at an average load factor of about 75 per cent. For the purpose of illustration the following typical figures may be assumed: A 100-kw. oil-engine generating plant costs $15,000 more than an installation for purchased power; the Diesel operating cost is 1.1c. per kw.-hr., or $187 a month; the total rate for purchased power is 2.28c. per kw.-hr., or $476 a month. The difference, $289, is the monthly saving effected by the Diesel plant and can be applied to repaying the original investment. The saving amounts to $3,470 a year, which is a return of 23 per cent on the original investment and will redeem the cost of the plant in about four years.

The total profit from the oil engine plant depends upon the number of years it is kept in useful service. Its physical life may be assumed to be twenty years, and if it is used for this length of time, the net profit will be $54,400. In a period of fifteen years the profit would be $37,050, and for even as short a time as ten years the net gain would be $19,700. EDGAR J. KATES.

New York City.

The Smoke Nuisance

THE Foreword in the Nov. 8, 1927, issue, on "The Smoke Nuisance" and the comments of Fred E. Bond in the Dec. 20 issue call attention to a problem that is becoming of increasing importance.

Fortunately, some of our larger cities are waking up to the urgency of the situation and are taking steps to combat the evil in a more efficient manner.

Important as the smoke nuisance is, in itself, there is great danger that if it is over-emphasized, we shall fail to realize that it is only one factor in a much broader problem, and it is not at all sure that in some cases it is the most important factor.

The inclusive problem is the elimination of air contamination, which may be considered from three major viewpoints—medical, economic and esthetic.

In considering the foregoing it is important that we should guard against the error of assuming that conditions that are wasteful or unpleasant, are in an equivalent degree unhealthy, although, undoubtedly, unpleasant conditions have a depressing effect which is not conducive to health. On the other hand, smoke forces itself so prominently upon our attention that we may fail to give proper consideration to other sources of air contamination that may be even more detrimental to health; for instance, the exhaust gases from automobiles.

It is questionable whether the average chimney discharges much which, in a dilute form, is of a particularly poisonous nature. Those who have had the doubtful pleasure of traveling in the old London underground tubes in the days when steam locomotives furnished the motive power generally felt that they were being poisoned, and yet statistics showed that the health of the employees was remarkably good.

It is now generally accepted that, to a large extent, the medicinal value of sunlight is attributable to the rays lying outside the visible spectrum, which are of course to a large extent absorbed by smoke and dust in the atmosphere, but it is not so generally recognized that absorption of a large part of these rays is inherent in the physical structure of modern cities independently of the condition of the atmosphere.

A considerable part of the sun's rays reaching a person in a city street flanked by tall buildings have been reflected and most of the ultra-violet rays absorbed or retransmitted as visible light, and no degree of clarity in the atmosphere will prevent this action.

Then again, most city dwellers spend a large part of

their time indoors, and window glass provides an effective filter for ultra-violet rays.

Of course it is not to be argued that a smoky atmosphere is not conducive to ill health, in spite of the fact that the average health of noticeably smoky cities is sometimes surprisingly good, but if we are to deal with the problem of air contamination in an effective manner, it is important that we should evaluate the factors involved correctly.

Perhaps the most valid of the more serious charges against smoke are economic and esthetic.

The general lay opinion is that a smoky chimney is wasteful and a clear chimney economical, but every engineer knows that this is far from being universally true. Of course smoke indicates a certain amount of waste, but a clear stack may be caused by an even more wasteful condition. One great difficulty is that the elimination of all possible smoke often costs too much to make it attractive to the boiler owner.

On the other hand, the secondary money losses due to smoke may possibly be considerably greater than those due to waste of fuel. I have lived in a city where it was necessary to change collars at least twice a day if one wished to look at all respectable. The defacement and deterioration of buildings and other property may easily reach huge sums annually, and the esthetic factor may also have an important economic bearing.

Recent developments in the combustion field have introduced a new factor into the situation. It is well understood that most of the ash from pulverized coal is discharged up the chimney, and in plants of any size this can be measured in tons per day.

The ill effect of breathing this dust is of course a subject for medical research, but it is reasonable to assume that it is far from negligible, and in some cases products of a more or less poisonous nature may be discharged.

If we define smoke in terms of color, which appears to be the only practical definition at present available, our somewhat inadequate instruments of observation, such as the Ringelmann charts, fail to register in any adequate manner the presence of other and perhaps more serious forms of contamination.

It appears to be necessary that more precise instruments with a wider range of operation be developed for accurately recording the different forms of pollution caused by smokestacks.

In considering this matter, sight should not be lost of the fact that the more smokeless forms of coal, such as anthracite, are becoming scarce and the price is rising, and many cities that are now using considerable quantities of this class of coal will become increasingly dependent upon fuels of a less smokeless character, which indicates the advisability of studying the development of new forms of fuels and their smokeless combustion.

The question of poisoning from the exhaust of automobiles is receiving an increasing degree of attention. Such investigations as have been made by different public authorities have been somewhat negative in their results, but here again there appears to be a scarcity of reliable means of investigation, and few cities appear to have the best instruments available.

Susceptibility to carbon monoxoide poisoning varies greatly, in different individuals, and cities have generally chosen policemen who may be assumed to be in first-class physical condition, to experiment with.

The conditions are variable, and altogether the investigation is a complicated one, but the deleterious effect of automobile exhaust cannot be questioned, and the danger is continually growing.

This is of course somewhat apart from the subject of black smoke, but if a broad view of the situation is not taken, the time may come when we shall find that we shall have to start much of the work over again and investigate the whole problem of air pollution in a thoroughly comprehensive manner. J. O. G. GIBBONS.

Newark, N. J.

Answers to What Do You Know

The questions are on page 285

Ans. 1—No, for the formula is based on the pressure at the inlet side of the nozzle There would be a pressure drop in the pipe due to frictional resistance, which would vary with the flow. It is necessary to use the formula for flow in pipes and ascertain at what point the flow through the nozzle would equal the flow through the pipe under the resulting pressure conditions. If these two functions are plotted against pressure, their intersection will give the correct value.

Ans. 2—The downward force acting on the elevator is that of gravity and is equal to what is termed its weight, and the upward force P is that causing the acceleration plus a force equal to gravity. Then P = gravity + Ma, when M is the mass of the loaded cage, that is $\frac{W}{32.2}$, and a is its upward acceleration. We can then write

$$P = 6{,}000 + \frac{6{,}000}{32.2} \times 6 = 7{,}118 \text{ pounds.}$$

Ans. 3—The hydraulic efficiency E_h is the ratio of the total head pumped against h to the total head pumped against plus all hydraulic losses, h_1, or $E_h = \frac{h}{h_1}$

Ans. 4—The angle the ball links make with the spindle and, consequently, the position of the collar are independent of the weight of the balls. The vertical distance of the plane of the balls from the cone top is found by the formula,

$$h = \frac{35{,}200}{n^2}, \text{ where } n = \text{r.p.m.}$$

Consequently, increasing the weight of the balls does not alter the position of the governor collar.

Ans. 5—Under the first assumption the engine would not pump air, but if its direction of rotation was reversed air would enter through the exhaust line and be delivered to the steam chest until the relief valves opened.

Ans. 6—It is generally agreed that no oil as oil exists in the shale, but there is a substance called kerogen which, upon the application of heat, leaves the shale and reappears as an oil.

Ans. 7—No, for the density of water at 30 deg. F. is the same as at 50 deg., consequently there would be no increase in water volume, and in addition the increased temperature would cause the tank to increase its dimensions.

Ans. 8—Run a connection from the steam space into the return line at a point even with the desired boiler water level.

Ans. 9—No. 4 Buckwheat must pass through a $\frac{3}{32}$-in. round hole or through a $\frac{1}{16}$-in. square-mesh screen.

The Future of Engineering

By DEXTER S. KIMBALL

Excerpts from an address on the occasion of the fiftieth anniversary of the organization of the Engineers Club of Philadelphia, December 17, 1927.

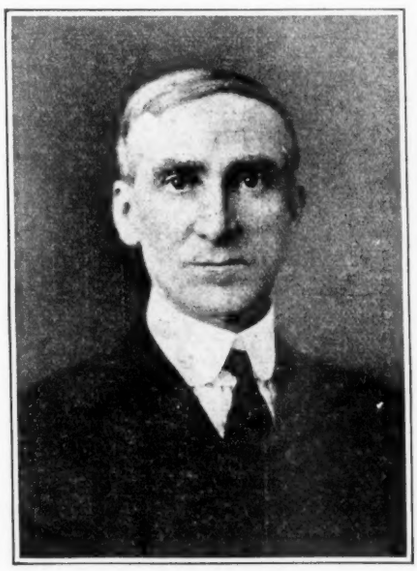
IN THE last fifty years we have rolled up the most prodigious store of wealth the world has ever seen. We are worth about four hundred billions of dollars; our national income is ninety billions, we have twenty-two million automobiles. And the average income is so great, the degree of well being is so high, that people naturally think in terms of great wealth and universal well being. Hence any prediction, and any discussion of what engineering is going to be in the future, is tied up closely with that hope.

First, I want to call attention to a very old economic law — the law of diminishing returns. This law, briefly, is that for every economic gain there is a corresponding economic loss, which always tends to reduce that gain. It has never been known to fail, and in discussing the great things of the future, I want to keep that in mind, because we are already reaching some of these limits.

The third item is communication, which is the most fascinating of all. The idea of communicating easily and rapidly is as old as man himself. The Indians and the ancients in the old countries used smoke, the Romans used heliographs, semaphores, and then, like all this great development, came the telegraph, the telephone, and then the radio. This is a field in which we can only conjecture. What is coming next? Shall we all go around with a receiver in our ears with which we can at any time listen to anything going on? Do these same waves strike upon unknown shores of planets far removed from the earth? Or shall we finally listen in to what is going on in these other planets? Possibly these rays that Doctor Milliken discovered may be signals from somewhere else. Who knows? Or, finally, as the farthermost speculation, shall we finally listen in to the great secret of the universe itself?

If we could do something with the wastes in this country, we probably could lift our entire social level, considerably. This is the land of the free; it is also the land of the wasteful and careless. Wastes are two kinds: first, personal, everyday waste. Waste of the ordinary American is something to marvel at. But these other industrial wastes which have been touched on are more far-reaching, and the engineers are beginning to reach out and check some of them. The first one he has undertaken to do something about is waste in management. That is already well under way. The engineering method of management has changed all our industrial viewpoints.

The first economists that wrote about wages laid down certain economic laws that were religiously taught by all professors since Adam Smith laid down the old iron law that wage is subject to the law of supply and demand. Mr. Taylor was the first one to announce that low costs and low wages do not necessarily go hand in hand. That was a new idea. He said the reverse was true, that high wages and low costs probably went hand in hand, if the matter was properly understood.



Dexter S. Kimball

Dean of Engineering, Cornell University, and Past-President American Engineering Council.

Now here are two interesting developments in different parts of the country that bear this out, and that have given a great deal of food for thought not only to economists but to engineers. Mr. Henry Ford, out of a clear sky, increased the wages of his men to five dollars, when the average wage was about three dollars, and everybody said he was making a mistake and that he could not do business on that basis.

About the same time, or nearly the same time, there appeared a little pamphlet written by Mangus Alexander. He called it "The Cost of Hiring and Firing Men." It had nothing at all to do with Mr. Ford. But his analysis of the cost of hiring and firing men showed that it cost about $150 (this was pre-war prices) to fire, as we say, a good machanic, and hire another one. And he told why. He had it all outlined, all the items that went into that cost. People also said that he was mistaken. As a natter of fact, he was under the true cost.

Now tie those two together. If Mr. Ford succeeded only in steadying his labor turnover, as we say, stopping somewhat the flow of men in and out of his plant, if he succeeded in curing, let us say, 10 to 15 per cent of that trouble, he probably made a lot of money.

Those were new thoughts, unlike any we had in industry before, and it was a beginning of a new era in our ideas of management, brought to us by engineers forcing themselves into this thing we call management.

One of the things that we inherited from England was the thing we speak of as the jury system. Under a handicraft civilization, one man's opinion on any subject was just as good as another's. Visualize that a bit. In a simple, handicraft civilization, one man's opinion is just as good as any other's because they all knew all that was going on.

Well, we have come a long way from a handicraft civilization, and one man's opinion is no longer as good as another's. As a matter of fact, 90 per cent of the things that we have in the city, the state and national government, are technical, scientific, engineering. And as a result of that we have such a thing as Muscle Shoals before us year after year. Now everybody knows that those things are engineering; three or four engineers, with a lawyer to keep them straight, could go down and tell them what to do with Muscle Shoals. It is no more difficult a problem than Niagara Falls or the State Line Power Plant, or forty other things. But there it is. We are trying to settle it by the jury system.

Congress spends all of one session wrestling over a farm relief bill which the President vetoes as being economically unsound. Economically unsound! And his word stands; nobody has yet been able to controvert it. Most of the great problems we have before us cannot be solved by the jury system; one man's word is not as good as another's. And nearly all of these things, in fact, 90 per cent of them, require special knowledge and special training in order to solve them. And that is engineering, remember; 90 per cent of them are engineering.

Our national government is run in exactly the same manner; exactly the same manner. The great problem of

the next fifty years is to bring to bear on these problems the same kind of intelligent analysis that has created them.

Now I don't mean to say that engineers ought to go to Washington to run the government; the Lord forbid! I know them too well. But I do say that until we can bring to bear on these problems intelligent analyses, not only of engineers, but of other specialists, these problems will be with us in just that form.

The great problem of the next fifty years will be to bring to bear on our national problems the same kind of intelligence that has created them, the same analysis, the same method of attacking them, because the engineering method of thinking is becoming the general method of thinking.

Mechanical Transmission Economies*

By William Staniar

Chairman Board of Advisory Engineers, Power Transmission Association

THE transmission or distribution of mechanical power is vastly different from the transmission of electric energy in many ways, and these differences are not as a rule difficult to understand with the exception of one, and that is, why a majority of executives and plant engineers have always underestimated, and still do, to a great extent, underestimate the importance of their power belting and mechanical transmission appurtenances. They demand expert engineering skill for the generation of their power and the selection and installation of apparatus, always with the idea of maximum production at minimum cost, but when it comes to belting, the most widely used and indispensible link between that power and maximum production, they place the responsibility for its selection, design, installation and care upon untrained men, their own limited belting experience and consideration of first cost only. The result is poorly designed drives, loss of power and depreciation of belting and transmission equipment, which together constitute a heavy and unnecessary percentage of production costs.

However, this state of affairs cannot economically continue to exist in present-day industrial operations because mechanical progress and competition have forced the recognition that belting and transmission machinery are no longer necessary evils, to be selected at random, installed and operated by antiquated methods, but are essential and important parts of plant operation, requiring and deserving as much care and attention as any other part of the mechanical equipment.

The average belting is easy prey for the deleterious fumes produced in chemical industries, and owing to the fact that explosives, dyestuffs, paints and varnishes, pyralin, artificial leathers, etc., are products of this industry, the Du Pont company faces high power transmitting costs. The purchase of type, selection of sizes, installation and care of belting are most important. Type and brand cannot be bought on discount, selection of size for the power and mechanical conditions cannot be left to untrained men, installation cannot be made in a slipshod manner and the care of the medium left to chance if economy of operation and production are given any consideration at all. The possible belting losses in all plants of the Du Pont company have been curbed by the installation of a belting standardization and schedule system.

This system of belting selection and control is a practicable and simple method for using the right belt in the right place as to type, width and thickness, because it is based on a detailed analysis of the following facts of each individual installation:

1. Conditions surrounding the drive, such as acid or acid fumes, heat, steam, moisture, grit, etc.
2. Power to be transmitted.
3. Speed ratios.
4. Diameter of pulleys, revolutions and velocities.
5. Center distance between shafts.
6. Method of control.
7. Angle of drive.
8. Top or bottom pull.
9. Method of loading.
10. Method of joining belt.

The analysis results in each individual belt drive of the entire plant should be scheduled in chart form, whether the belt in question is 3 in. or 24 in. wide, because in most cases the function of the 3 in. medium is just as important as that of the 24 in. The building up of such schedules is greatly facilitated by existing plant belt records, that is, if they are comparative as to type, etc. However, if no records are available, it is necessary to inaugurate a program of testing. This is done sectionally, or one test of the various types for each acid, heat, steam, moisture or grit condition existing and, of course, the mechanical conditions involved. It should be borne in mind, however, that reliable belting performance tests under actual operating conditions are as a rule difficult to obtain, because they are generally hampered by the personal opinions and preconceptions of maintenance forces and operators, therefore particular pains are taken to eliminate the personal equation in this work.

Investigations have shown that where there is no systematic method of mechanical power transmission control, belting and belt maintenance costs generally follow production labor costs, therefore it has been interesting to note the effect of the schedule system on this relation.

Power wasting transmission installations are not always confined to old plants. Many modern establishments can exhibit glaring examples, but in the majority of these cases it is not through the lack of knowledge or consideration of modern methods and equipment. It is because the transmission of mechanical power has been forgotten up to the last moment. Great care has been given by the designers to type, style and size of buildings and all materials entering into their construction; great skill has been displayed in the arrangement of apparatus, the finest kind of heating and ventilating equipment has been specified, then finally as a rule it is realized that the actual production apparatus must be driven and driven mechanically. What is the result? Motors, shafting, belting, speed reducers, etc., must be squeezed into small spaces and impracticable methods employed because it must be operated, and any way is best regardless of power, maintenance and production losses.

In most plants, whether they be of the modern or old-style construction, the shafting and belting system is the most extensively employed owing to its flexibility. However, developments of recent years have brought methods and systems for the economical distribution of mechanical power that were never heard of in the past, and no doubt electrical research and the perfecting of the electric motor are responsible for the divorce of industry from the old power-consuming methods of transmission. Mechanical inventive genius has kept pace with electrical development, because it was realized that the high-speed energy of the motor could not be applied to the general run of machinery without suitable and economical reduction methods, therefore, many systems such as direct flexible coupled motor connection, worm and spur gear reduction units, roller or silent chain connections, V-shaped multiple rope connections, modern idler systems or direct exposed gear reductions have been devised for accomplishing this purpose. All these methods or systems have their place and should be considered during the design of new work and as improvements on existing operating installations.

*From an address before Power Transmission Association.

RECENT PUBLICATIONS

A.S.T.M. Standards, 1927. Two volumes: Part I, Metals, and Part II, Non-Metallic Materials. Published triennially by the American Society for Testing Materials, Philadelphia. 1,871 pages. Price: cloth, $14, half leather, $17.

STANDARDS adopted by the American Society for Testing Materials are published in book form every three years. Standards adopted in the intervening years are published in supplements. The next official book of standards to be issued by the society will, therefore, not be published until 1930. The present volumes will remain as the official compilation of specifications for materials and of testing methods until that time.

In the present issue are a number of standards, adopted since the 1924 volumes appeared, that are of interest and value to power plant engineers. Among these are standard A70-27, specifications for boiler and firebox steel for stationary service; A89-27, specifications for steel plates of flange quality, for forge welding; A83-27, specifications for lap-welded and seamless steel and lap-welded iron boiler tubes; A53-27, specifications for welded and seamless steel pipe; A96-27, specifications for alloy-steel bolting material for high-temperature service; A72-27, specifications for welded wrought-iron pipe; B23-26, specifications for white-metal bearing alloys; B55-25, specifications for seamless 70-30 brass condenser tubes and ferrule stock; B56-25, specifications for seamless Muntz-metal condenser tubes and ferrule stock; B57-27, specifications for Muntz-metal condenser tube plates.

These standards all apply to metal products used in the power plant. Another group is concerned with non-metallic materials of like application. Included in this latter group are: C53-27, specifications for quicklime for use in water treatment; C54-27, specifications for hydrated lime for use in water treatment; D157-27, test for steam emulsion of lubricating oils; D240-27, test for thermal value of fuel oil; D88-26, test for viscosity of petroleum products and lubricants; D95-27, test for water in petroleum products and other bituminous materials; D271-27, sampling and analysis of coal and coke; D121-27, definition of terms relating to coal and coke; D48-27, methods of testing molded insulating materials; D117-27, methods of testing electrical insulating oils; D182-25, D183-25, D184-25, specifications for partial-immersion thermometers for general use; in various ranges.

Hundreds of other standards, old and new, are included in these two volumes. These standards cover all types of materials and testing methods. Any power plant large enough to purchase or use much material will find them a help to maintaining economy in its operations.

Electrical Control Gear and Industrial Electrification. By William Wilson. Published by Oxford University Press, London, England, and 35 W. 32nd St., New York City, 1927. Cloth; 6x8¼ in.; 361 pages; 216 illustrations; 26 tables. Price, $8.50.

NOTWITHSTANDING the importance of control equipment it has not received the attention in technical literature that the motor has. In fact, it has been within the last ten years only that practically all control literature has been made, and this new book is a valuable contribution to a rapidly growing art. In the treatment the author has endeavored to provide a book that would be of service to the student, the practicing engineer, and the operator.

The work has been divided into 23 chapters and an appendix. In the first three chapters general principles and the various types of direct-current and alternating-current motors are considered. Ten chapters treat of the different types of controllers, contactors, relays, interlock and electric braking. Discussion of the various classes of solid resistors and liquid rheostats has been made an important part of the book. Treatment of specific applications include electric elevators, electric cranes and gantries, steel mills, machine tools, electric furnaces, mine hoists, paper and printing machinery.

Although such systems of control as Ward Leonard, Ilgner sets with slip regulation and Holmes-Clatworthy have been given extensive attention, other important systems of speed control, such as the Kramer, Scherbius and synchronous converter have been omitted. In view of the extensive developments in paper-machine control a more extensive treatment could have been given to this subject than has been alotted to it.

A valuable part of the work is the numerous tables giving the size of motors required for different kinds of drives. These include haulage systems; the various classes of machine tools, both individual drive and in groups; wood-working machinery; printing; textile; steel rolling mills; and miscellaneous machinery.

The treatment is more from the practical viewpoint than from the theoretical. A number of formulas have been given in the various chapters, but these in nowise interfere with the readability of the book for those who may be interested in the practical side of the subject.

Engineering of Power Plants. By R. H. Fernald and George A. Orrok. Third Edition. Published by McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; 663 pages; illustrated. Price, $5.50.

THIS excellent book, the first edition of which appeared about ten years ago, is well known to power engineers. However, the last few years have seen such marked changes in power plant practice as affecting furnace design, increase in steam pressures, the application of pulverized coal, employment of the regenerative cycle, air preheating, etc., that a complete revision and amplification of much of the text became necessary. Data on station and equipment performance have been added, which are especially valuable; also a number of heat balance diagrams of well-known plants have been included.

No attempt has been made to segregate steam engines and steam turbines, both of which are treated under a chapter headed "Steam Engines," although considerable space is devoted to each. Such segregation might have been an aid to the reader.

The chapter on internal combustion engines has been revised to cover later developments in the Diesel.

The fact that over fifty pages devoted to the gas producer have been retained in the revised volume should not be interpreted that this is now an important factor in power production in this country, but rather that much of this material is fundamental and applies also to the production of gas for industrial uses.

It is to be regretted that the authors did not revise much of the power plant equipment cost data. The book is replete with such data, but for the most part they represent prewar prices, which are of little use to the average reader who may not possess the proper indexes with which to apply these figures to present conditions.

Aside from the last-mentioned point, the book represents one of the latest and most authoritative texts on power plant practice.

Mechanical World Electrical Pocket Book. Published by *Mechanical World*, London, England, 1928. Cloth; 4x6-in.; 400 pages; 134 illustrations. Price, 50 cents.

THIS is the twenty-first edition of this book, which is issued annually. It contains practical information on a great many electrical subjects, such as alternating-current systems, motors and generators; storage batteries; rotary converters; wire and cables; illumination; locating faults in direct-current and alternating-current motors, etc. There are also many tables giving the sizes of motors required for various types of drives; properties of insulated copper wire; fusing current in amperes; capacity of storage batteries; areas and circumferences of circles; and data on overhead and traveling cranes.

NEWS *of the* FIELD

Long Established N.A.S.E. Now Known As National Association of Power Engineers

National Referendum Ballot Passes by 1,657 Votes Proposal by Michigan No. 7 of Detroit—Only 547 Vote Against It—Association Members of Cincinnati Hold Celebration

THE long established National Association of Stationary Engineers is now the National Association of Power Engineers.

This change in the title of the organization, proposed in the recent referendum ballot, by Michigan No. 7 of Detroit, was carried by a majority of 1,657 votes, 2,204 members of the association casting their choice for the new name, and 547 voting against it.

"It has taken us 45 years to graduate from the overall, monkey-wrench, and hammer engineer into the professional class as power engineers, writes Thomas Herlihy in his national vice-president's letter, commenting on this change, in the February issue of the *National Engineer*. Engineering in all its branches is a profession, and should be so recognized. The educational courses offered by the National Educational Committee are second to none in the country, and if taken advantage of, by our young members particularly, should put the National Association of Power Engineers in the forefront of engineering societies."

Following closely upon this general announcement, the Combined Associations of National Association of Stationary Engineers of Cincinnati gave their sixth annual banquet and dance at the Gibson Hotel roof garden, Feb. 11, and celebrated the important change in the long sustained activities of the national organization.

Past National President Garret Burgess, National President Elmer L. Bassett, National Secretary Fred W. Raven, Educational Director N. K. Chamberlin and Egbert Douglas contributed short addresses. Prominent Cincinnati officials also lent their support to the success of the evening by giving inspiring talks.

Those on the banquet committee—Wiley Craig, chairman, A. J. Batchlor, vice-chairman, Cris Moytern, secretary, and D. C. Hunt, treasurer, also J. P. Brown, George Hoffman, George Bock, William Sanders and Frank Ernst—were responsible for the success of this the largest affair given by the members of the association in Cincinnati.

Plans are now being made for the 1928 National Convention in Detroit next September.

Lehigh Power, National Power & Light Companies Merge

A plan for the merger of the Lehigh Power Securities Corporation and the National Power & Light Company was announced Jan. 26. The Lehigh Corporation serves communities in eastern Pennsylvania, while the National Power Company controls companies in North and South Carolina, Tennessee, Alabama and Texas.

Consulting Engineers Re-elect Officers

At a meeting of the Chicago Association of Consulting Engineers held at the City Club on the evening of Jan. 16, the annual election of officers was held and the present officers were re-elected for the ensuing year, as follows: Irving E. Brooke, president; Ernest V. Lippe, vice-president, and Rollo E. Gilmore, secretary-treasurer. This is the beginning of the eighth year since the association was organized. The membership consists of consulting engineers engaged in mechanical, electrical and sanitary engineering, who are in no way connected with the sale of equipment or apparatus.

Last Stage Wheel on 12,500 Kw. Turbine Breaks at Bridgeport

On Jan. 17, at the Steel Point plant of the United Illuminating Company, Bridgeport, Connecticut, the last stage wheel on a 12,500-kw. turbine-generator unit broke, causing considerable damage to the exhaust casing and the surface condenser. The unit, which is a nine-stage 1,800-r.p.m. machine, had been in service about two years. At the time of the accident it was being brought up above speed to test the overspeed trip gear and, it is reported, had reached a speed of 1,900 r.p.m. when the wheel gave way.

An investigation is being made into the cause of the accident and *Power* hopes to publish the full details in an early issue.

Dr. William C. L. Eglin Passes Away

Dr. William C. L. Eglin, widely known electrical engineer and president of the Franklin Institute for five terms, died at the Jefferson Hospital, Philadelphia, the night of Feb. 7, after a four weeks' struggle against a nervous breakdown. He was in his fifty-eight years.

As vice-president and chief engineer of the Philadelphia Electric Company, Mr. Eglin was largely responsible for the hydroelectric development nearing completion at Conowingo, Md. In 1908 and 1909 he had served as president of the National Electric Light Association. He was regarded as a leading authority on electric lighting.

Mr. Eglin was born in Glasgow, Scotland, and took a course in the Andersonian University of that city. He at the same time attended special classes at the University of Glasgow, where Lord Kelvin, then Sir William Thomson, was a professor.

Coming to this country in 1888, he obtained employment with the Edison Electric Light Company of Philadelphia.

Mr. Eglin had owned one of the most comprehensive collections of manuscripts, letters, drawings and experimental memoranda of M. Faraday brought to this country. This he presented to the Franklin Institute shortly before his death.

The University of Pennsylvania, Swarthmore College and other institutions had conferred honorary degrees upon him. He was a past vice-president of the Engineers Club of Philadelphia, a Fellow of the American Institute of Electrical Engineers and one of its vice-presidents, and associate member of the Edison Pioneers, and a member of other scientific and fraternal bodies.

He had contributed many papers on technical subjects to engineering and allied journals, notably on the modern steam turbine, and had lectured on electric utility problems at Princeton, Swarthmore and the University of Pennsylvania.

Iowa N.E.L.A. Hears Progress at Annual Meeting

Electrical service is available to 97.7 per cent of the urban population of Iowa, according to George Neal, Fort Dodge, vice-president of the Iowa section of the National Electric Light Association, who reviewed the state's progress in the industry at the annual meeting in Cedar Rapids, Feb. 2 and 3, attended by 350 members of the organization. Production in 1927 amounted to approximately 1,403,684 kw.-hr., an increase over 1926 of almost 60,000 kw. hr., Mr. Neal stated.

Sioux City was chosen for the 1929 convention and C. A. Nordstrom and C. E. Murphy of Sioux City were named members of the convention committee. Directorate of the section for the year is composed of Ray F. Ingham and E. G. Nichols, Cedar Rapids; M. A. Harpster, Mason City; V. O. Stafford, Waterloo; Messrs. Nordstrom and Murphy, Sioux City; George L. Perrine Centerville; Ira Steele and Charles Clark, Des Moines; E. A. Wesco and H. M. Bailey, Dubuque; C. A. Nash, E. S. Schreiner, E. J. Otterbein and J. H. Tegtmeier, Davenport; A. R. Battern, Fort Dodge.

Talks by Prominent Leaders

Prominent among a score of speakers at the meeting were Thorne Brown, Lincoln, Neb., managing director of the midwest section, who discussed political attitude toward the utilities; Paul S. Clapp, managing director of the National Electric Light Association; A. B. Campbell, of the National Association; Frank D. Paine, director of the Iowa Community for Electrical Development and Francis St. Austell, president of the Iowa Radio Listeners' League, who decried tendency to enact ordinances in attempt to eliminate radio interference and made a plea for co-operation with the utilities concerns as the most practical method of avoiding the troubles complained of by radio users.

To Study Economic Currents of United States

Secretary Hoover has appointed a committee of leading business men and economists whose names will be announced later, to supervise a far-reaching inquiry into the changes in economic currents in the country. Private individuals have subscribed the necessary money to enable the committee to pay the expenses of the Bureau of Economic Research of New York, to make the fact-finding background, and the co-operation of the Department of Commerce will be given.

It is proposed to determine facts concerning such questions as the shifts in employment, changes in methods of production in industry and agriculture, and in distribution, shifts in relative price levels and profits, movements in the business cycle, shifts in standards of living, foreign trade and foreign credits, and other allied subjects that bear upon an understanding of the general business situation of the country. It is expected that the inquiry will take some months and will be made of most exhaustive order.

Five years ago a similar survey was made under similar auspices, from which came a greatly improved understanding of the major business currents.

Date for Reporting Boulder Dam Bill Agreed Upon

The House Committee on Irrigation and Reclamation Feb. 3 agreed on March 15 as the date upon which a favorable report will be made to the House on the Swing bill, to provide for power development, flood control, water storage and irrigation on the Colorado River at the proposed Boulder Dam site.

Announcement of the action of the Committee was made orally by Representative Smith (Rep.), of Twin Falls, Idaho, chairman, after an executive session. Mr. Smith also made public the resolution adopted by the committee fixing the date for the favorable report and Commissions of the seven interested suggesting that the Colorado River States resume their negotiations in an effort to adjust interstate differences over the proposed legislation.

Assurances that every effort will be made to obtain a State compact for the development were conveyed to the House Committee on Irrigation and Reclamation Feb. 7 from authorities of four of the interested states, Utah, New Mexico, California and Nevada.

The assurances were given in telegrams to Representative Smith, commenting on the action of the Committee in withholding a report until March 15, so that the states might endeavor to reach an agreement.

Twenty Year Club of Portland Dines

When the Twenty Year Club of the Portland Electric Power Company, Portland, Ore., held the annual meeting Jan. 18, sixty persons were voted into membership. During the past year 14 members have died, out of 328. T. W. Sullivan, hydraulic engineer in the Oregon City office of the company, is president of the club. Other officers are R. B. Robley, superintendent of operations in the light and power department and H. C. Schade, of the investment department, secretary.

This club holds a large banquet once a year. Appearing on the program this year was George L. Baker, mayor of Portland and Franklin T. Griffith, president of the Portland Electric Power Company.

Byllesby Engineers to Hold Third Annual Convention

The third annual convention of the engineering department of Byllesby Engineering and Management Corporation will be held in Chicago, Feb. 14-17, according to an announcement by H. W. Fuller, vice-president in charge of engineering and construction. About seventy engineers and construction superintendents will be in attendance.

Papers will be presented on the application of chemistry to the control of the operation of steam power plants; the construction of Prospect No. 2 power plant with emphasis on distinctive features, special methods and construction devices, difficulties encountered and overcome; a discussion of the year's progress in the electrical industry; what elements of a project must be supplied to the construction organization so that construction may progress smoothly and efficiently; construction of the Byng power station; meeting construction emergencies; the Brunot Island switch house; recent developments in the manufacture of artificial gas; contemporary European practice and tendencies in steam power plant design and operation; recent additions to the Colfax plant of the Duquesne Light Company; the organization of the engineering and construction activities of the Byllesby properties; and construction problems of the Chippewa Falls water power plant.

Conference to Be Held on Indiana Fuel

The Indiana Fuel Conference will be held at Purdue University, Lafayette, Ind., April 5 and 6, 1928, under the direction of the Engineering Extension Department and the School of Mechanical Engineering, with the School of Chemical Engineering of Purdue University, co-operating.

The tentative program includes a meeting on Thursday afternoon, April 5, at which papers will be presented on the fuel resources of Indiana, fuel and power as affecting progress, and fuel research problems. At the Friday morning meeting a sympsosium on burning Indiana coal will be presented, also papers on how many engineers, producers and consumers co-operate, and on coal storage. At the afternoon meeting, among the subjects planned for are smoke elimination, coal marketing, fitting the coal to the plant and standardizing market methods. The final program will be announced later.

Project in Saskatchewan

The Northern Light & Power Company, Estevan, Saskatchewan, Canada, is planning a $5,000,000 power project, which will serve a large area in southeastern Saskatchewan The plan calls for the erection of a large power plant near Estevan, where power will be developed from lignite coal.

Dr. Pupin Honored by Washington Award

DR. MICHAEL PUPIN, of Columbia University, noted scientist and inventor, was presented with the Washington Award for preëminent service in the promotion of human happiness, comfort and well being. The presentation was made on the evening of Feb. 2 in the Grand Ball Room of the Palmer House, Chicago, in a brilliant function sponsored by the four founder national societies and the Western Society of Engineers. Following the banquet, with 450 in attendance, Maj. Rufus W. Putnam, president of the Western Society of Engineers, reviewed the founding of the award by John Watson Alvord, and named the previous recipients. R. F. Schuchardt, chairman of the award commission and also chairman of the meeting, eulogized the honored guest and introduced the various speakers of the evening.

Achievements Outlined

Speaking for President Max Mason, of the University of Chicago, Prof. Arthur Compton, Nobel prize winner last year, outlined what Doctor Pupin had accomplished in the realms of invention and development. The most notable of his accomplishments were his method of loading telephone cables which made long-distance telephony possible, the tuned circuit and the resonant system now used as a basis of all radio broadcasting, rectification of alternating currents and development of X-ray photography.

Representatives of the four national societies followed with expressions of felicitation and hearty concurrence in the award. Dr. A. N. Talbot, a previous recipient, spoke for the American Society of Civil Engineers; Dr. William Kelly, of Iron Mountan, for the American Institute of Mining and Metallurgical Engineers; John Lyle Harrington for the American Society of Mechanical Engineers, and Bancroft Gherardi, president of the American Institute of Electrical Engineers, for his society.

Discusses Long Distance Telephone

In his response Doctor Pupin dwelt particularly upon the long-distance telephone. All large industrial centers in this country were being connected into one telephonic community and Europe would follow suit. In this rapid interchange of ideas he saw a factor for world peace, because nothing was so conducive to friendship as thought expressed by the living voice. Referring to Herbert Hoover, the first recipient of the Washington Award, he said; "This man understands well that some of the greatest national problems today are engineering and economic problems. He has the same engineering intuition that Washington had." This faculty and his remarkable executive ability made him far superior to the politician and led to the prediction that in all likelihood this competent engineer would be the next President of the United States.

Dr. Pupin Receiving Certificate from R. F. Schuchardt (right)

Engineering Institute of Canada to Hold General Meeting

Arrangements have been made by the Engineering Institute of Canada to hold its Annual General Professional Meeting, Tuesday to Thursday, Feb. 14 to 16, 1928, with headquarters at the Windsor Hotel, Montreal. Tuesday will be devoted to business and committee meetings, with a lecture of general interest in the evening.

On Wednesday and Thursday five technical meetings will be held, at which nine papers will be presented and discussed. It has been arranged to visit a number of engineering works on Wednesday afternoon, and the annual dinner of the Institute will be held in the evening.

Papers of particular interest to *Power* readers are: "Notes on the Uniflow Steam Engine," by E. A. Allcutt, based on tests made by the author on the economy and performance of this type of engine, "The Electrical Heating of Power-Plant Trash Rack," by C. R. Reid, giving methods of dealing with fragile ice in the St. Maurice River, Quebec; "Notes on the Removal of Carbon-Sulphur Compounds from Coal Gas by Oil Washing," by K. L. Dawson, giving the results of experimental work carried out on a commercial scale; "The Requirements for a Durable Concrete as Observed from Structures in Service," by R. B. Young; and "The Effects of Steam Treatment of Portland Cement Mortars on Their Resistance to Sulphate Action," by T. Thorvaldson and V. A. Vigfusson.

Contracts Awarded for Back River Project

Contracts have just been awarded for the big power development of the Back River Power Company, on the Back River, near Montreal. P. Lyal & Sons Construction Company will construct all the dams, waterways and power houses necessary for the development. The value of this contract is placed at approximately $2,500,000. The Canadian General Electric Company has been awarded the contract for all electric equipment. The Dominion Engineering Works, Ltd., a subsidiary of the Dominion Bridge Company, Ltd., and the Canadian Allis-Chalmers Company, Ltd., share in the work of building the necessary waterwheels involved in the undertaking.

The Back River site is capable of developing 65,000 hp. under a 26-ft. head. It is expected that the initial 40,000-hp. will be available for delivery by the end of 1929. The power plant will consist of a number of units of 7,500 hp. each, and while the 24-hour production rating of the plant when completed is 65,000 hp., the maximum capacity of the installation will be in the vicinity of 92,000 hp.

Reports Power Resources of Umpqua River Basin, Ore.

That the Umpqua River Basin in southwestern Oregon possesses huge potential power resources exceeding those of any one of more than half of the states, has been officially stated by the Department of the Interior through the Geological Survey. There is, however, but one small developed site in the basin, on North Umpqua River near Roseburg, where a plant of 1,900 hp. has been built. Proposed power sites at Rock Creek, Boundary, Toketee Falls and Lemolo Falls on North Umpqua River, and one on Clearwater River are being investigated by a large power company under a permit from the Federal Power Commission.

Potential Power of Proposed Sites on Umpqua

Twenty-two power sites are proposed for Umpqua and North Umpqua Rivers. The estimated potential power at these sites without storage amounts to 216,000 hp. for 90 per cent of the time and 477,000 hp. for 50 per cent of the time. With storage, it is 313,000 hp. for 90 per cent of the time and 450,000 hp. for 50 per cent of the time. If all plants were operated as one system, a minimum output of about 350,000 hp. could be obtained in an ordinary year. In 1926, under the assumed conditions of operation, a minimum output of 287,000 hp. could have been obtained. These estimates of potential power with storage assume that the Perdue and Days Creek reservoirs on South Umpqua River would also be built.

Fifteen power sites are proposed on South Umpqua River and Fish Lake Creek, including the two proposed reservoirs at Perdue and Days Creek. The total potential power at these sites without storage amounts to 8,300 hp. for 90 per cent of the time and 61,000 hp. for 50 per cent of the time.

Data Assembled and Analyzed in Report

The total potential power of the Umpqua River Basin without storage is 247,000 hp. for 90 per cent of the time and 584,000 hp. for 50 per cent of the time. With storage, these figures can be increased to 369,000 hp. for 90 per cent of the time and 561,000 hp. for 50 per cent of the time. With unified operation the power available 90 per cent of the time could be increased in an average year to over 400,000 hp., of which 350,000 hp. would be developed on Umpqua and North Umpqua Rivers, 17,000 hp. on Clearwater River, and 9,000 hp. on Mill Creek.

The Geological Survey has collected the fundamental data for the basin, such as records of stream flow and river surveys, and these have been supplemented by a field examination by B. E. Jones, hydraulic engineer, and H. T. Stearns, geologist, who have assembled and analyzed the data in a manuscript report. This report may be examined at the Geological Survey, Washington, D. C., or at the district office of the Geological Survey, Post Office Building, Portland, Ore.

Utilities in Washington Merge

The Washington Water & Power Company, one of the largest industrial concerns in the Northwest, with main offices in Spokane and power plants in several towns in eastern Washington, was merged with the American Light & Power Company Jan. 18, the latter company acquiring control through the purchase of a majority of the common stock.

Personal Mention

Walter G. Eickler has been appointed superintendent of maintenance and power for the Faulkner & Colony Manufacturing Company, Keene, N. H.

H. W. Dillon, formerly sales engineer, Chicago Pneumatic Tool Company, Philadelphia, Pa., has accepted a similar position with Gold Car Heating & Lighting Company, New York City.

Paul C. Reichard, mechanical engineer, recently graduated from Lehigh University, is now engaged in the motive power department of the New York Central R.R., at Avis, Pa.

E. R. Norris, formerly director of works equipment for the Westinghouse Electric & Manufacturing Company, and previously assistant works manager for the company, has been promoted to the position of general works manager of all manufacturing operations.

William F. Traudt has been re-elected president of the Taber Pump Company, Buffalo, N. Y. Mr. Traudt has been associated with that company for 18 years as executive and mechanical engineer. He is well known in the field for his patents on various pumping equipment and related devices.

Edward D. Dillard, who joined the electrical engineering department New England Power System in 1919, has been promoted to electrical engineer. Stanley D. Stoddard is now assistant electrical engineer. Mr. Stoddard joined the company in 1919 as electrical designer, coming from the H. M. Hope Engineering Company.

W. L. Newmeyer, member of the A.I.E.E., who has been with the Westinghouse Electric Company of Japan, has recently been selected to represent the Westinghouse company in China. In 1916 Mr. Newmeyer joined the Westinghouse Company and after the war in 1920, he worked in the switchboard engineering department until 1924. While in this department he assisted R. J. Wensley in developing automatic switching equipment. He has been with the Westinghouse Electric Company of Japan since 1924.

Business Notes

The Brown Instrument Company announces the opening of a new branch office in San Francisco, Calif.

The Dampney Company of America, Hyde Park, Boston, announces that the sale of its Apexior protective coatings for power plant equipment will be handled in central and western New York by the Stone Company, 1219 Commerce Bldg., Rochester, N. Y.

The International Power & Paper Company, a subsidiary of the International Paper Company, has acquired the property and assets of the Newfoundland Power & Paper Company, Ltd., which include a 400-ton daily capacity newsprint mill at Corner Brook, a 98,000-hp. hydro-electric power plant and 2,802 acres of timber land in Newfoundland. The company was acquired from British interests.

W. H. Nicholson & Company, of Wilkes-Barre, Pa., manufacturers of Nicholson Steam Traps, Separators, Three and Four-Way Valves and other steam specialties, have recently placed the agency for the Cities of Utica, Syracuse and Rochester, together with the surrounding counties, in the hands of Arthur E. Jones Company, 415 S. A. & K. Bldg., Syracuse, N. Y. They have also placed the Counties of Western Ohio in the hands of C. Keiser & Company of 2010 Ravenwood Avenue, Dayton, Ohio.

Private Utilities Company, Kewanee, Ill., has elected A. J. Anderson president of the concern which manufactures electric light plants, water supply systems and sewerage disposal plants for isolated buildings. Zenophon Caverno, head of the company, since its inception 25 years ago, continues as a director, the board of which was increased from three to five. M. B. Coghlan, Chicago, has been appointed new sales manager for the firm.

The Wagner Electric Corporation, St. Louis, announces the opening of a new branch sales office located at 475 West Peachtree St., Atlanta, Ga., to cover the three states of Georgia, Alabama and Florida, until recently a part of the St. Louis sales territory. Mr. Roy F. Druschky, until recently in the St. Louis territory, has been put in charge of the Atlanta branch office. The opening of this new branch is designed to assure a closer contact between the Wagner corporation and their motor, transformer and fan customers in Alabama, Georgia and Florida.

THE HARRISBURG FOUNDRY & MACHINE COMPANY, INC., Oct. 13, sold its plant to Christian W. Lynch, Harrisburg, Pa., who formerly operated the plant for approximately ten years. This sale was approved by the Court Oct. 28, 1927, since which time Mr. Lynch has been operating the plant in the name of the Harrisburg Foundry & Machine Company, Inc. Corporate papers have been applied for, and a charter was issued on Dec. 16, 1927. As soon as the organization can be effected, it will consist of Christian W. Lynch, president; B. E. Taylor, secretary and treasurer; Benjamin T. Allen, chief engineer. It is the plan of the new management to continue building the Harrisburg dual clearance uniflow engine and such other products as are adaptable to the plant. The chief engineer, Benjamin T. Allen, has been identified with this plant for a period of 35 years and has been responsible for the engineering development.

Coming Conventions

American Institute of Electrical Engineers, winter convention at New York City, Feb. 13-17, F. Hutchinson, secretary, 29 West 39th St., New York City; St. Louis Regional Meeting, District No. 7, March 7-9; Baltimore Regional Meeting, District No. 2, April 17-19; New Haven Regional Meeting, Northeastern District, No. 1, in May; Summer Convention, in Denver, June 25-29.

American Institute of Refrigeration, Washington, D. C., May 10-11.

American Society of Mechanical Engineers, spring meeting in Pittsburgh, May 14-17; Calvin Rice, secretary, 29 West 39th St., New York City.

American Society for Testing Materials, Atlantic City, June 25-29.

American Water Works Association, Annual meeting, Hotel Fairmont, San Francisco, June 11-16; W. M. Niesley, 170 Broadway, New York City.

Association of Iron and Steel Electrical Engineers, annual convention at Hotel Stevens, Chicago, June 25-29.

Chicago Power Show to be held at the Coliseum, Feb. 14-18. G. E. Pfisterer, manager, 53 W. Jackson Blvd., Chicago.

Midwest Power Conference to be held at the Hotel Stevens, Feb. 14-17; G. E. Pfisterer, secretary, 53 W. Jackson Blvd., Chicago.

National Association of Stationary Engineers, annual convention at Detroit, Sept. 11; Fred Raven, 417 South Dearborn St., Chicago.

National Board of Boiler and Pressure Vessel Inspectors, meeting at Erie, Pa., June 18-20.

National Electric Light Association, Convention and exhibition, Atlantic City, N. J., June 4-8; A. Jackson Marshall, secretary, 420 Lexington Ave., New York City.

National District Heating Association, annual meeting at Ambassador Hotel, Atlantic City, June 12-15; D. J. Gaskill, sec., 112 West 4th St., Greenville, Ohio.

The National Marine Engineers' Beneficial Association, 53rd annual convention, will meet at the Lee House, 15th and L Streets, N. W., Washington, D. C., February 13-18. Albert L. Jones, Secretary-Treasurer, 313 Machinists Building, Washington, D. C.

Stoker Manufacturers Association, fall meeting at Greenbrier Hotel, White Sulphur Springs, W. Va., Oct. 22-24.

Universal Craftsmen Council of Engineers, Newark, N. J., Aug. 7-10.

Trade Catalogs

ELEVATOR CABLE EQUALIZERS—Evans Elevator Equalizer Company, Bedford, Ind., has just issued a new 20-page catalog describing the Evans elevator-cable equalizer. This catalog, in addition to describing the equipment, gives considerable space to considering the causes and results of unequal rope tension in elevator cables, and the remedies for these difficulties.

EVENT RECORDER — The Esterline-Angus Company, Indianapolis, Ind., has brought out a new line of time recorders that are applicable to a wide range of duties. These machines are suitable for such power-plant services as recording the time when switches or valves are opened and closed, the revolution of heaters and stokers, the opening and closing of oil circuit breakers, etc.

VALVES—The Edwards Valve & Manufacturing Company, East Chicago, Ind., has ready for distribution a new 143-page catalog listing its line of non-return, globe, angle, blow-off, feed line and atmospheric relief valves. Certain lines of these valves are for pressure ranges up to 1,350 lb. This catalog is well illustrated with cross sections of the various equipment, which are accompanied by detailed descriptions of operation. Dimensions, weights and list prices are also included.

TRAVELING CRANES — Industry is more and more insisting that manual labor be avoided as much as possible in the handling of heavy materials. In answer to the demand for information covering such equipment as traveling cranes, electric crane trolleys, jib cranes, etc., the Whiting Corporation, Harvey, Ill., has just issued a 72-page catalog, No. 209, which describes various types of Whiting hoists, many of which are particularly adapted for power-plant use.

S & C HIGH-POTENTIAL FUSES—Schweitzer & Conrad, Inc., 4435 Ravenswood Ave., Chicago, Ill., have issued a new catalog on high-potential fuse. These fuses are for voltages ranging from 2,200 to 132,000 and for current ratings of one-half to 400 amperes. The catalog contains much useful information on the requirements for interrupting high-voltages circuits, tests made on high-voltage fuses, how high-voltage fuses function, and on the application of these fuses.

STEEL-PLATE BLOWER—A new bulletin No. 3504 has been issued by the American Blower Corporation, Detroit, Mich., covering its type *SE* steel-plate blower. This pamphlet not only shows the various parts entering into the construction of the blower, but also gives a table of dimensions, including capacity, speed and horsepower of the various sizes.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; **mine run, except Pittsburgh gas slack:**

Bituminous (Net Tons)	Market Quoting	Jan. 26, 1928
Navy Standard...	New York.....	$2.25@$2.50
Kanawha.....	Hampton Roads	1.63@ 1.98
Smokeless.....	Cincinnati.....	2.25@ 2.50
Smokeless.....	Chicago.....	2.25@ 2.50
S. E. Kentucky...	Chicago.....	1.40@ 1.60
Steam.....	Pittsburgh.....	1.40@ 1.65
Gas Slack.....	Pittsburgh.....	1.15@ 1.35
Big Seam.....	Birmingham....	2.00@ 2.25
Anthracite (Gross Tons)		
Buckwheat.....	New York.....	$3.00@$3.35
Birdseye.....	New York.....	1.60@ 1.85

FUEL OIL

New York—Feb. 2, light oil tank-car lots, 28@34 deg. Baumé, 5c. per gal.; 36@40 deg., 6c. per gal., f.o.b. Bayonne, N. J.

St. Louis — Jan. 24, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.55 per bbl.; 26@28 deg., $1.60 per bbl.; 28@30 deg., $1.65 per bbl.; 30@32 deg., $1.70 per bbl.; 32@36 deg., gas oil, 4.276c. per gal.; 38@40 deg., 5.23c. per gal.

Pittsburg—Jan. 12, f.o.b. local refinery, 30@34 deg., fuel oil, 4¼c. per gal.; 36@40 deg., 4¾c. per gal.

Philadelphia—Feb. 1, 26@30 deg., $2.00@$2.06 per bbl.; 13@19 deg., $1.26 @$1.32 per bbl.; 22 plus, $1.58@$1.64 per bbl.; 27@30 deg., $2.10@$2.16 per bbl.

Cincinnati—Jan. 31, tank-car lots f.o.b. local refinery, 24@26 deg. Baumé, 4.9c. per gal.; 26@30 deg., 5.15c. per gal.; 30@32 deg., 5½c. per gal.

Chicago—Jan. 28, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl.; 22@26 deg., 80@85c. per bbl.; 26@30 deg., 90c. per bbl.; 30@32 deg., $1.05@$1.10 per bbl.

Boston—Jan. 30, tank-car lots, f.o.b. 12@14 deg. Baumé, 4¼c. per gal.; 28@ 32 deg., 5.8c. per gal.

Dallas—Jan. 28, f.o.b. local refinery, 26@30 deg., $1.45 per bbl.

NEW PLANT CONSTRUCTION

Ark., Malvern—International Shoe Co., 1501 Washington Ave., St. Louis, Mo., is having preliminary plans prepared for a textile mill here. Estimated cost $1,000,000. Private plans.

Calif., Fort Mason—Constructing Quartermaster, Washington, D. C., will soon award contract for the construction of a refrigeration plant at Power house 25, Letterman General Hospital here.

Calif., Fullerton—Bd. of Education, plans an election soon to vote $600,000 bonds for the construction of a high school.

Calif., Los Angeles—E. Bean, 1007 North Western Ave., will build an 8 story hotel on Hudson Ave. by day labor.

Calif., Los Angeles—Corp., c/o J. Martyn Haenke, 1120 Subway Terminal Bldg., Archt., is having plans prepared for a 12 story hotel including steam heating and electric refrigeration systems, elevators, etc. at Highland and Franklin Aves. Estimated cost $1,000,000.

Calif., Los Angeles—Palomine Health & Beauty Institute, is having preliminary sketches made for a 12 story hotel, etc. Estimated cost $500,000. H. P. Sharp, 409 H. W. Hellman Bldg., is architect.

Calif., Riverside—U. S. Government, Washington, D. C., is receiving bids for the construction of a group of buildings including administration building hangars, radio and shop building, etc. here. Estimated total cost $2,000,000.

Calif., San Francisco—The Great Western Power Co., of California, 530 Bush St., subsidiary of North American Co., 60 Broadway, New York, N. Y., awarded contract for the design and construction of a 35,000 kw. steam power plant including 450 lb. boilers, etc. here to McClellan & Junkersfeld, Inc., 68 Trinity Pl., New York. Estimated cost approximately $4,000,000.

Ill., Chicago—Campbell Soup Co., Camden, N. J., awarded general contract for the construction of a 6 story plant here to Henry Ericcson Co., 228 North La Salle St. Estimated cost $1,000,000.

Ill., Chicago—Chicago Women's Club, Fine Arts Bldg., is having sketches made for a 5 story club building at 56 to 76 East 11th St. Estimated cost $750,000. Holabird & Roche, 104 South Michigan Ave., are architects.

Ill., Chicago—Commonwealth Edison Co., 72 West Adams St., awarded contract for masonry, etc. for a sub-station at 6239 Prairie Ave. Estimated cost $200,000.

Ill., Chicago—H. H. Decker, 400 North Michigan Ave., is having preliminary sketches made for a 17 story apartment building at Burnham Park and Chicago Beach Dr. Estimated cost $2,100,000. Holabird & Roche, 104 South Michigan Ave., are architects.

Ill., Chicago—East Chestnut St. Building Corp., c/o Rissman & Hirschfeld, 228 North LaSalle St., Archts., awarded contract for masonry, etc. for a 19 story apartment building at 222 East Chestnut St. Estimated cost $1,000,000.

Ill., Chicago—Edgewater Athletic Club, F. A. Harkness, Secy., 105 West Monroe St., awarded contract for a 15 story club building at Sheridan Rd. and Ardmore Ave. to Thompson-Starrett Co., 104 South Michigan Ave. Estimated cost $2,500,000.

Ill., Chicago—Passavant Memorial Hospital, 26 West Erie St., awarded general contract for a 13 story hospital at East Superior St. and Fairbanks Court, to G. A. Fuller & Co., 140 South Dearborn St. Estimated cost $2,000,000.

Ind., Anderson—W. A. Clark, 538 Main St., plans the construction of a warehouse including cold storage plant at Fifth and Main Sts. Estimated cost $160,000. Architect not selected.

Ind., Bloomington—Graham Hotel Co., awarded contract for a 6 story hotel at 6th and College Ave. to Leslie Colvin, 823 Continental Bank Bldg., Indianapolis. Estimated cost $600,000. Steam heating system, elevators, etc. will be installed.

Ind., Fort Wayne—N. Goldman, is having plans prepared for a 6 story department store building including elevators, etc. at Wayne and Calhoun Sts. Estimated cost $1,000,000. A. M. Strauss, 415 Cal-Wayne Bldg., is architect.

Ia., Carlisle—City plans and election Feb. 23, to vote $27,000 bonds for waterworks improvements including well, pump house, deep well pump, tank on towers, etc. W. E. Buell & Co., 205 Davidson Bldg., Sioux City, are engineers.

Ia., Des Moines—Bankers Life Co., Gerard S. Nollen, Pres., Sixth St. and Grand Ave., is having preliminary plans prepared for the construction of an office building at 31st St. and Grand Ave. Estimated cost $2,000,000.

Ia., Des Moines—First Baptist Church, 8th and High Sts., is having preliminary sketches made for an 8 story church, hotel and stores building. Estimated cost $1,000,000. Architect not selected.

Ia., Cedar Rapids—City, H. F. Blomquist, supt., plans an election Mar. 26 to vote $500,000 bonds for waterworks improvements including deep well, pumping plant, water softening and filtration plant, etc.

Md., Cumberland—Zantzinger, Borie & Medary, 112 South 6th St., Philadelphia, Pa., Archts., will receive bids until Mar. 4 for the construction of a hospital including steam heating and electric refrigeration systems, elevators, etc. here for Memorial Hospital, c/o architects. Estimated cost $500,000.

Mass., Brockton—Brockton Edison Electric Illuminating Co., A. F. Nelson, Mgr., 42 Main St., is having plans prepared for the construction of a power sub-station. Estimated cost $75,000. C. C. Mason, c/o owner, is engineer.

Mich., Detroit—Finsterwald Co., Michigan Ave., had plans prepared for a 13 story mercantile building including steam heating system, boilers, elevators, etc. on Michigan Ave. A. Kahn, 1000 Marquette Bldg., Archt.

Mich., Flint—Hotel Commodore Apartment Building Corp., c/o W. G. Carnagie, 6 North Clark St., Chicago, Ill., Archt., will build a 12 story hotel including steam heating and refrigeration systems, boilers, elevators, etc. Estimated cost $550,000. Work will be done by separate contracts.

Mich., Niles—City, J. L. McOmber, Clk., will receive bids until Feb. 15 for the construction of a power house and dam, 150 ft. long, effective head 22 ft. including a 50 hp. turbo-generator. W. Fett, South Bend, Ind., is engineer.

Mo., Anglum—B. F. Mahoney & Co., San Diego, Calif., will receive bids about Mar. 1, the construction of an airplane factory including power and heating plant, etc. on Near St. here. Estimated cost $75,000. McDonald & Condie, 502 North Taylor Ave., St. Louis, Mo., are architects.

Mo., St. Louis—Nassau Realty Co., 316 North 8th St., plans the construction of a 17 story addition to hotel at Eighth and St. Charles St.

N. J., East Orange—Thirty Nine Prospect St. Corp., c/o H. R. Van Duyne Inc., Managing Agents, 790 Broad St., Newark, awarded contract for a 10 story co-operative apartment building at 35-43 Mt. Prospect St. to Salmon Scrim, Shaw & Co., 526 Elm St., Arlington, Steam heating and refrigeration systems, boilers elevators, etc. will be installed.

N. Y., Albany—A. W. Fuller of Fuller & Robinson, State St., Archts., will receive bids until Feb. 16 for the construction of a new Albany Law School on New Scotland Ave. Estimated cost $450,000 to $500,000.

N. Y., Brooklyn—Brooklyn Eye & Ear Hospital, J. H. Post, Pres., 129 Front St., New York, had plans prepared for a 7 story hospital at Cumberland St. and Greene Ave. here. Estimated cost $1,000,000. Crow, Lewis & Wick, 200 5th Ave., are architects.

N. Y., New York—Tammany Hall, G. W. Olvany, 292 Madison Ave., plans the construction of a club building including elevators, etc. at Union Sq. and East 17th St. Estimated cost $600,000. Thompson, Holmes & Converse, 101 Park Ave., are architects. C. B. Meyers, 31 Union Sq., is associate architect.

N. Y., New York—Alan Realty Co., A. E. Lefcourt, Pres., will build a 23 story stores and loft building at 38th St. and Broadway. Estimated cost $1,800,000. Bark & Dyorup, 1351 Broadway, are architect. Work will be done by separate contracts.

N. Y., New York—Louis Security Corp., M. Greenstein, 206 West 29th St., is receiving bids for a 20 story loft and office building at 576 8th Ave. Schwartz & Gross, 347 5th Ave., Archts.

N. Y., New York—Second Presbyterion Church, G. J. Russell, 3 West 95th St., plans the construction of a church and apartment building at 96th St. and Central Park W. Estimated cost $1,750,000. Architect not selected.

N. Y., New York—Telcour Holding Corp., P. Uris, Pres., 271 Madison Ave., had plans prepared for a 15 story hotel at 541 Lex-

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mgton Ave. Estimated cost $3,000,000. E. Roth, 1440 Broadway, is architect.

N. Y., New York—Three Hundred Seventy Lexington Ave. Corp., F. W. Woodward, Pres., 347 Madison Ave., had plans prepared for a 30 story hotel at 366 Lexington Ave. Estimated cost $3,000,000. W. L. Rouse, 512 5th Ave., Archt.

O., Cincinnati—Reading Road Apartment Co., 301 Provident Bank Bldg., will soon award contract for a 7 story apartment building on Reading Rd. Estimated cost $750,000.

O., Columbus—Bd. Trustees, Ohio State University, C. E. Steeb, Secy., will soon award contract for a 112 x 120 ft. addition to power plant. Estimated cost $160,000.

O., Columbus—Galbreathe & Leonard Inc., 42 East Gay St., is having plans prepared for the construction of an apartment building on East Tower St. Estimated cost $500,000. D. W. Moore, 387 East Broad St., is architect.

O., Fostoria—Union National Bank, plans the construction of an office, bank and stores building on Main St. Estimated cost $700,000.

O., Lakewood—Syndicate, c/o C. R. Cummins, Pres. of C. R. Cummins Co., Penton Bldg., Cleveland, Contrs., is having plans prepared for a 10 story hotel at Edgewater and Love Sts. Estimated cost $2,000,000. F. W. Bail, Hanna Bldg., Cleveland, is architect.

O., Toledo—Catholic Diocese of Toledo, will receive bids until Feb. 17 for the construction of a central high school. Estimated cost $1,000,000. Comes, Perry & McCullen, Renshaw Bldg., Pittsburgh, Pa., are architects.

Okla., Fort Cobb—City, W. S. Rains, Clk., will soon award contract for waterworks improvements including deep well pump and motor, 50,000 tank on tower, etc. Estimated cost $30,000. C. A. Wood, Stillwater, is engineer.

Okla., Oklahoma City—Harbour-Longmire Co., 420 West Main St., had plans prepared for the construction of a 9 story store building including steam heating, ventilation and refrigeration systems, elevators, etc. on Main St. Estimated cost $1,000,000. Hank & Parr, Cotton Exchange Bldg., are architects.

Okla., Tulsa—C. P. Alexander, Alexander Bldg., will build an 8 story loft building including steam heating system, elevators, etc. and 5th and Main Sts. Estimated cost $500,000. L. I. Shumway, Alexander Bldg., is architect.

Ore., Portland—G. C. Mason & Associates, Failing Bldg., had plans prepared for the construction of a public market including steam heating, ventilation and refrigeration systems, boilers, pumps, elevators, etc. at Morrison and Tyler Sts. Estimated cost $1,500,000. Private plans.

Pa., Mayview—Dept. of Charities, E. Rauh, Dir., awarded contract for the construction of a group of buildings for city home and hospital to Nicola Building Co. Estimated cost $1,576,726.

Steam heating system, etc. will be installed.

Pa., Philadelphia—The Blum Store, M. Spector, 13th and Chestnut Sts., awarded contract for a 10 story store building to Wark Co., 1600 Walnut St. Estimated cost $700,000.

Pa., Philadelphia—Uptown Realty Co., 2240 North Broad St., awarded contract for a 5 story theatre and office building to Cramp Co., Deuckla Bldg. Estimated cost $500,000.

Pa., Philadelphia—J. J. Greenberg, Morris Bldg., plans the construction of a 12 story warehouse at 23rd and Vine Sts. Estimated cost $2,500,000. P. S. Tyre, 114 South 15th St., Archt.

Pa., Pittsburgh—Engineer Office, Washington, D. C., plans the construction of a power house, Lock No. 6, on Allegheny River.

R. I., Cranston—City Lease & Building Co., c/o G. B. Long, 470 Atlantic Ave., Boston, Mass., is having plans prepared for the construction of a bakery and warehouse including loading shed, etc. here. Private plans. The Great Atlantic & Pacific Tea Co., Somerville, Mass., is lessee.

Tex., El Campo—Central Power & Light Co., Frost Bldg., San Antonio, is receiving bids for the construction of a 25 ton ice plant here. Estimated cost $40,000.

Tex., Galveston—Bureau of Yards & Docks, Navy Dept., Washington, D. C., plans the construction of a radio compass station, also overhead and underground electric lines, etc. here.

Tex., Galveston—John Sealy Hospital, E. Randall, Sr., Chn. Building Committee, will receive bids until Feb. 21 for the construction of a power plant, etc. Estimated cost $200,000.

Tex., Galveston—Standard Ice Co., plans the construction of an ice plant. Estimated cost $25,000. Work will probably be done by day labor.

Tex., Graham—City plans an election soon to vote bonds for waterworks improvements including dam, pumping plant, mains, etc. Hawley & Freese, Capps Bldg., Fort Worth, are engineers.

Tex., Hidalgo—Hidalgo Utilities Co., A. Y. Baker, has been granted permit to construct an ice plant. Estimated cost $45,000. Private plans.

Tex., Lubbock—Texas Technological College, is having preliminary surveys made for the construction of an administration building, library, dairy manufacturing building, heating plant, etc. Estimated total cost $1,039,000. Private plans.

Tex., Lufkin—G. A. Kelly, J. L. Phillips & Associates, have acquired the Livingston ice plant and plans to remodel same to increase the capacity from 10 to 22 ton. Estimated cost $30,000. Machinery and equipment will be required.

Tex., Mineral Wells—Texas Utilities Co., E. P. Broadhead, Supervisor, plans the construction of a 60 ton ice plant at N.W. 2nd St. Private plans.

Tex., New Braunfels—San Antonio Public Service Co., E. H. Kifer, 201 North St. Marys St., San Antonio, awarded contract for an additional unit to power plant including a 45,000 hp. steam turbine, etc. at Comal plant here, to United Gas & Improvement Co., c/o Comal Plant, New Braunfels. Estimated cost $1,500,000.

Tex., Port Arthur—Gulf Coast Utilities Co., Beaumont, will build an ice plant here, by day labor. Estimated cost $75,000. Machinery and equipment will be required.

Tex., Quanah—West Texas Utilities Co., Abilene, awarded general contract for first unit of power plant, 15,000 kw. capacity on Lake Pauline, five miles from Quanah to R. E. McKee, 1916 Texas St., El Paso. Estimated cost $300,000.

Va., Norfolk—Gardner Bakeries Inc., subsidiary of General Baking Co., 420 Lexington Ave., New York, N. Y., is having preliminary plans prepared for the construction of a baking plant here. Estimated cost $500,000. Architect not announced.

Va., Quantico—Supervising Architect, Treasury Dept., Washington, D. C., will receive bids until May 15 for the construction of an apartment building, storehouse, mess hall and power house at Marine Barracks here. Estimated cost $900,000.

Wash., Seattle—Bd. of Public Works, awarded contract for new electrical equipment for unit 6 of Cedar Falls hydro-electric project to Westinghouse Electric & Mfg. Co., 3451 East Marginal Way. $65,867.

Wash., Seattle—Olympic Community Hotel Co., F. W. Hull, Mgr., Henry Bldg., plans the construction of a 10 story hotel at Fifth and University Sts. Estimated cost $500,000.

Wash., Seattle—Stimson Realty Co., Douglas Bldg., is having plans prepared for a 15 story office building at Fourth and Union Sts. Estimated cost $1,000,000. R. C. Reamer, Douglas Bldg., Archt.

Wash., Spokane—L. N. Rosenblum, Railway Exchange Bldg., Seattle, is having plans prepared for an 8 or 10 story medical center building here. Estimated cost $2,000,000. A. G. Rigg, Peyton Bldg., is architect.

Wis., Marinette—Badger Building Service, c/o Peacock & Frank, 445 Milwaukee St., Archts. and Engrs., plans the construction of an 8 story hotel and theatre building on Place St. Estimated cost $500,000.

Ont., Ottawa—Community Hotel Co., Ltd., L. N. Paulin, Pres., Sparks St., plans the construction of a hotel on Metcalfe St. Estimated cost $1,000,000.

Ont., Ottawa—Dominion Government, is having plans prepared for a testing laboratory. Estimated cost $1,000,000. T. Fuller, Dept. Public Wks. Archt.

Que., Montreal—Property Corp. of Canada Ltd., J. J. Fitzgerald, 157 Wilson St., plans the construction of a 10 story apartment building on Burnside Pl. Estimated cost $1,500,000. Architect not selected.

Equipment Wanted

Boiler—U. S. Engineer Office, War Dept., Washington, D. C., plans to purchase a marine boiler at New Orleans, La.

Boilers—O. Pee Chee Co., 618 Dundas St., London, Ont., will receive bids until Feb. 16 for steam boilers, etc. for proposed factory.

Boilers—U. S. Engineer Office, 428 Customhouse, St. Louis, Mo., will receive bids until Feb. 15 for furnishing and installing new boilers, etc. in U. S. Dredge "Fort Chartres."

Boilers, Pumps, Condensers, Etc.—Oklahoma Gas & Electric Co., Insurance Bldg., Oklahoma City, Okla., plans to purchase two boilers, circulating pumps, condensers, etc., for proposed 40,000 hp. turbo generator unit at Harrah, Okla. Estimated cost $2,000,000.

Electrical Equipment—Jackson Ice & Fuel Co., D. P. Coll, Mgr., Jackson, O., plans to purchase complete electrical equipment for proposed ice manufacture plant.

Ice Plant Equipment—Owner, c/o C. S. Klein, 1016 Detroit Savings Bank Bldg., Detroit, Mich., Archt., plans to purchase ice making equipment for proposed ice plant. Estimated cost $100,000.

Ice Plant Equipment—Southern Ice & Utilities Co., Odessa, Tex., plans to purchase soon machinery and equipment for proposed ice plant. Estimated cost $55,000.

Power Equipment—Gulf States Utilities Co., Beaumont, Tex., plans to purchase additional power equipment probably including new engine, etc. for proposed extensions and improvements to light and power plant at El Paso, Tex. Estimated cost $100,000.

Pump—Town Council, Pembroke, Ont., will soon receive bids for a 1,400 g.p.m. pump for water supply unit.

Pumping Equipment—City of Lockwood, Mo., plans to purchase pumping equipment, etc. for proposed waterworks improvements. Estimated cost $55,000.

Pumping Equipment—Village of Bensonville, Ill., plans to purchase pumping equipment, etc. for proposed waterworks improvements. Estimated cost $35,000.

Pumps—U. S. Engineer Office, Washington, D. C., plans the installation of two 20 in. dredging pumps, etc. for U. S. Dredge Galveston, Galveston, Tex.

Pumps, Etc.—Bd. of Comr., De Witt, Ark., will receive bids about Mar. 10 for two pumps, etc., for proposed sewage treatment work. Estimated cost $60,000.

Pumps and Motors—W. C. Roberts, Clk., Mangun, Okla., will receive bids until Feb. 29 for three deep well pumps and motors for proposed extensions and improvements to waterworks. Estimated cost $135,000.

Pumps, Motors, Engines, Etc.—Town, of Palmerston, Ont., F. A. Dallyn, Engr., is receiving bids for one 850 g.p.m. centrifugal pump, direct connected to electric motor, starter and push button control, one 850 g.p.m. double suction centrifugal pump direct connected to gasoline engine and one 350 or 400 g.p.m. deep well pump directed to motor, etc. for proposed waterworks improvements.

Refrigeration Equipment—Bd. Trustees, Locust Mountain State Hospital, Shandoah, Pa., plans the installation of complete refrigeration equipment.

Refrigeration Equipment—New State Ice Co., 2 West 3rd St., Oklahoma City, Okla., plans to purchase refrigeration equipment for proposed 60 ton ice plant. Estimated cost $125,000.

Switchgear—Dept. of Public Works Supplies & Tenders Committee, Wellington, N. Z., will receive bids until Mar. 27 for an 11,000 v. switchgear for Lake Coleridge Electric power scheme.

Transformers, Switches, Switchboard, Motors, Etc.—Consumers Power Co., 129 Pearl St. N.W., Grand Rapids, Mich., plans to expend $1,500,000 for improvements including the installation of transformers and switches for new 140,000 v. line between Muskegon and Grand Rapids, auxiliary switchboard with three 450 hp. transformers for Wealth St. plant, motors for operating governor oil pumps and airbrakes for generating units at Croton dam.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

LITTLE change is evident in current prices of power plant and electrical supplies, compared with January levels. All of the steel items are firmer in view of the fact that base prices on the principal hot-rolled products at Pittsburgh, are mounting steadily. The advances on structurals, per 100 lb., base, Pittsburgh, in carloads, have been as follows: November, 1927, $1.75; December, 1927, $1.80; February, 1928, $1.85. Weakness in the non-ferrous metals market caused a slight drop (4c. per lb.) in highest grade babbitt, compared with price on Jan. 10.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		(net) 68c. per ft.
Common, 2½-in., cotton-rubber lined	80c. per ft. list, less	50%

Air—Best grade

¾-in., per ft.	3-ply	$0.36½	4 ply	$0.44

Steam—Discounts from List

First grade	30–10%	Second grade	40%	Third grade	45%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade	45%	Second grade	50%

LEATHER BELTING—List price, 24c., per lin.ft. per inch of width, for single ply, at New York warehouses:

Grade	Discount from list
Medium	35%
Heavy	30%

RAWHIDE LACING—For cut, best grade, 30–10%; 2nd grade, 50–10%. For laces in sides, best, 46c. per sq.ft.; 2nd, 42c. Semi-tanned, cut, 30–10%.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.95
Asbestos for high-pressure steam, ⅛ in.	1.75
Duck and rubber for piston packing	.95
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.30
Rubber sheet	.50
Rubber sheet, wire insertion	.80
Rubber sheet, duck insertion	.60
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ¼- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		50%
Asbestos, air cell, for low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.25@2.35 per bbl. without bags, in carload lots, delivered by truck to site of job. Bag charge, 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.34 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York	Cleveland	Chicago
White	10.00@13.50	16.00	15.00@20.00
Colored	9.00@13.00	12.00	12.00@17.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed, white wipers, as follows:

Chicago	$0.15
New York	15½@17½
Cleveland (per thousand)	36.00

LINSEED OIL—These prices are per 7½-lb. gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$0.76½	$0.86	$0.78

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry		In Oil	
	Current	1 Yr. Ago	Current	1 Yr. Ago
Red	$13.75	$15.25	$15.25	$16.75
White	13.75	15.25	13.75	15.25

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Tank rivets, small, including ½-in. dia., list (Apr. 1, 1927) less 50-10% in full keg lots, for immdeiate delivery from warehouse stocks in New York and vicinity.

Structural rivets, per 100 lb.:

New York	$5.00*	Chicago	$3.60	Pittsburgh mill	$2.75

Cone-head boiler rivets, per 100 lb.:

New York	$5.00*	Chicago	$3.60	Pittsburgh mill	$2.90

*Price is for full keg lots; broken keg lots, $6.50 net

REFRACTORIES—Prices in car-load lots, f.o.b. plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome cement, 40@50% Cr_2O_3, in bulk	per net ton	22@25
Chrome cement, 40@50% Cr_2O_3, in sacks	per net ton	26@29
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, Soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa	per M	43.00
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	35@38
Chrome ore crude, 40@50%	per net ton	18.00@22.50

BABBITT METAL—Delivered, New York, cents per lb.:

Genuine, highest grade	72.00
Commercial genuine, intermediate grade	61.00
Anti-friction metal, general service	31.50
No. 4 babbitt (f.o.b.)	12.50

COLD DRAWN STEEL—Warehouse prices per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Shafting and screw stock, round and hexagon	$3.30	$3.65	$3.60
Flats and squares	3.80	4.15	4.10

BOILER FITTINGS—F. o. b. New York or Jersey City, discounts from list:

	Current
Copper ferrules	70%
Boiler flanges	65-5%
Boiler stay bolts	60%
Boiler patch bolts	20%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Steel			Iron		
Inches	Black	Galv.	Inches	Black	Galv.
1 to 3	62	50½	1 to 1½	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	47½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	2
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are net prices per 100 ft. at New York warehouses on tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$17 07
1¼	.....	.....	19 20
1½	.....	$38 00	17 92
1¾	.....	28 50	20 48
2	$17.33	25 00	20 24
2¼	19 84	28 25	23 00
2½	21 60	34 00	26 03
3	25.50	42 50	27 04
3½	30.25	49 50	30 67
3¾	31.50	52 75	33 33
4	38.03	67 00	40.11

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net per 100 ft. based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

2 in. and smaller.. 5c. per cut. 3 in..... 9c. per cut.
2¼ and 2½ in..... 6c. per cut. 3½ to 4 in.... 10c. per cut.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent. 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$30.00 (net)	$46 00 (net)	$180.00	$220.00
No. 12 solid	136.00	180.00	225.00	275.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	305.00	375.00	420.00	500.00
No. 6 stranded	440.00	530.00	615.00	.....

From the above lists discounts are:		Lead Covered
Less than coil lots	50%	20%
Coils to 1,000 ft	60%	30%
1,000 to 5,000 ft	65%	35%
5,000 ft. and over	67%	38%

CONDUIT—Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, per 100 pieces, f.o.b. New York, with 10-day discount of 5 per cent.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
¼	$56.50	$61.34	$7 76	$8.83	$4.52	$4.92
⅜	72.07	78 63	10 21	11.63	6.46	7.03
½	103.31	113.00	15 10	17 21	8.39	9.13
¾	139.77	152 88	20 51	23 07	11 78	12.75
1	167.12	182 79	27 34	30 76	14.56	15.75
1¼	224.85	245 94	50.13	56 40	19 41	21 01
1½	355 50	388 85	82.03	92 28	27.73	30 01
2	464.88	508 50	218.74	246.10	41.59	45.01
2½	585.30	637.74	483.04	543.46	55.46	60.02
3	714 17	776.30	558.23	628.06	69.32	75.02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0 31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$17.75
No. 16 cotton reinforced heavy		22.00
No. 18 cotton reinforced light		14.50
No. 16 cotton reinforced light		18.35
No. 18 cotton Canvasite cord		14.75
No. 16 cotton Canvasite cord		17.20
No. 16 super service cord or similar (2 wire) in 1,000 ft	$72.00	*80.00
No. 14 super service cord or similar (2 wire) in 1,000 ft	110.00	*122.00

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.,	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	30	35-amp. to 60-amp.,	100	.60
61-amp. to 100 amp.,	50	90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard Package, 64%; standard package, 70%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4 00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1
REFILLS—				
1 to 30-amp.	$0.03 ea.	$0.05	100	100
35 to 60-amp.	.05 ea.	.06	100	100
65 to 100-amp.	.10 ea.	.10	50	50
110 to 200-amp	.15 ea.	.15	25	50
225 to 400-amp	.30 ea.	.30	25	25
450 to 600-amp	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than standard package	22%
Standard package	40%
Discount Without Contract—Renewals:	
Less than standard package	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less than standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package (500)	$2.50
0-30 ampere, less than standard package	2.80

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard A type bulbs:

100—130 Volt			200—260 Volt		
Watts	Type	Price Each	Watts	Type	Price Each
				Special	
15	A 17	$0.23	25	A 19	$0.28
	General		50	A 21	.28
25	A 19	.23	100	A 23	.50
40	A 21	.23			
50	A 21	.25			
60	A 21	.25			
100	A 23	.40			

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$6.00	$9.30	$10 90	$17.50
12	9.95	12.50	14 50	24.60
10	13.20	16.25	18.30	31.00
8	19.10	22.50	24 00	43.00
6	.....	.....	33 75	....
4	.....	.....	47.50	....
2	.....	.....	66 75	.....
1	.....	.....	92 00	.....
0	.....	.....	113 00	.....
00	.....	.....	134 50	.....
000	.....	.....	161 00	.....
0000	.....	.....	191 50	.....

SOCKETS, BRASS SHELL—Price each, net:

	½ In. or Pendant Cap			¾ In. Cap		
	Key	Keyless	Pull	Key	Keyless	Pull
Standard package	$0.11	$0.11	$0.18	$0.16½	$0.15	$0.22
Unbroken carton	.14	.13	.20	.18	.16	.23
Broken carton	.16	.15	.22	.20	.18	.25

WIRING SUPPLIES—

Friction tape, ¾ in., less than 100 lb., 31c. per lb.	100 lb. lots	29c. per lb.
Rubber tape, ¾ in., less than 100 lb., 33c. per lb.	100 lb. lots	31c. per lb.
Wire solder, less than 100 lb., 33c. per lb.	100 lb. lots	31c. per lb.
Soldering paste, 2 oz. cans		$1.00 doz

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c. or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25 .00 to $50.00 list value	30–5%
$50.00 list value or over	35%